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A Disposal Option for Navy and MARAD Ships

MICHAEL V. HYNES, JOHN E. PETERS,
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PREFACE

Over the next 20 years, after accounting for unfunded forms of ship disposal such as donations, sales, or transfers to foreign governments and private interests, more than 350 Navy and Maritime Administration (MARAD) vessels will require some form of government-funded disposal. A previous RAND Corporation study (Hess et al., *Disposal Options for Ships*, MR-1377-NAVY, 2001) reviewed such disposal options, including recycling (either domestically or overseas) and long-term storage. Preparation and use of ships for construction of artificial reefs was identified as the lowest-cost domestic option for ship disposal.

In the research reported here, we examine the demand for ships as reefs and the impediments to such use. We suggest program goals and review possible business models for their potential to minimize risks and costs to the Navy. While it had been our intention to conduct a more-thorough analysis, the U.S. Navy, for which this research was conducted, found our preliminary results satisfactory for its purposes and asked that we not proceed further. Our reefing analysis is thus suggestive, rather than definitive.

For the reader's convenience, a synopsis of the earlier study is included in this briefing. Some of the findings have been updated to reflect information coming to our attention since that report was published.

This briefing should be of interest to the U.S. Navy, MARAD, the U.S. Coast Guard, and coastal commissions along the eastern and western U.S. seaboards.

This research was conducted within the Acquisition and Technology Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Commands, and the defense agencies.

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SUMMARY

By 2005, the U.S. Navy and the Maritime Administration (MARAD) will have accumulated some 360 retired ships in need of disposal. These ships include military ships of various types, plus commercial ships in the Ready Reserve administered by MARAD. In previous decades, these ships would have been recycled, or "scrapped," by recycling yards in either the United States or overseas, and the federal government would have realized some monetary gain. U.S. shipyards can no longer economically recycle ships, and concerns about environmental and safety conditions in foreign recycling yards have led to suspension of that disposal option.

In a previous study (Hess et al., 2001), we assessed the recycling options, along with two other ship-disposal options—keeping ships in storage indefinitely and donating them for use as artificial reefs. We concluded that reefing was the least-expensive feasible option. In fact, economic activity associated with reefs could generate taxes at various levels of government that together would be sufficient to offset federal costs. Overseas recycling was also judged to be inexpensive, possibly even a no-cost option, but U.S. Environmental Protection Agency (EPA) regulations prohibit the export of items contaminated with polychlorinated biphenyls (PCBs), a category into which military ships fit. Domestic recycling would now have to be funded by the U.S. government, and long-term storage would require regular protective measures and occasional dry-docking to counteract the corrosive effects of salt water. Either approach would be more expensive than reefing.

Having demonstrated the potential attractiveness of reefing as a disposal option, we turned in the current study to an examination of economic, legal, environmental, and programmatic issues that might bear on a decision on whether and how to pursue the reefing option more seriously. Our conclusions are as follows:

- There is plenty of demand for ships for reefing, particularly along the mid- and southern-Atlantic and Gulf coasts. There are at least 400 sites ready to accept ships. The federal government may thus have the luxury of choosing among applicants according to criteria such as a match of funds at some level.

- Many elements of the institutional apparatus required to implement a reefing program are in place. Most coastal states have artificial-reef programs, and regional fishery commissions coordinate state interests. MARAD has donated ships for reefing projects, some after transfer of title from the Navy. Precedents may also be found in the National Fisheries Enhancement Act of 1984, which permitted the conversion of exhausted oil rigs to reefs, and in the Coast Guard's routine practice of retiring its ships for reef use. The Army Corps of Engineers has a permitting process in place that ensures artificial reefs do not obstruct navigation. The Federal Aid in Sport Fish Restoration Act of 1950 provides a potential source of funding for state or local reef-building entities, which operate on very limited resources.

- Environmental concerns have been raised, chiefly with respect to the release of PCBs from sunken ships into the littoral environment. A Navy testing program is allaying some of these fears, and a new EPA process for approving unusual disposals is in place. There is, thus, a basis for an EPA permitting process for reefing, and a further basis can be found in standards established by Canada for that purpose. Other environmental issues appear not to be as serious as the PCB issue.

- Two further problems need to be addressed before a reefing program can be pursued:

  - The programs will need a business model. Will the Navy or MARAD run the reefing program itself? Or will a separate agency or federal corporation be established? Or will the Navy or MARAD retain ownership while a contractor operates the program? Or could both ownership and reefing be put out for bid? These alternatives entail differing mixes of costs and risks for the Navy, the resolution of which is beyond the scope of this study. Whichever model is chosen, however, it would be most attractive to reef-building entities if there were a single point of contact within or under contract to the federal government. Likewise, it would be most efficient for the contact if it had to deal with only the states—that is, if each state decided which proposals were most meritorious and put those forward under its name.

  - Certain laws would have to be amended. A provision against spending federal money on reefing would probably have to be repealed. Unless title of all ships to be reefed is to be transferred

to MARAD, the Navy will need clearer authority to donate ships for reefing. It may also need broader authority to transfer ships for reefing to another agency. Finally, of course, authorization and appropriations acts will have to provide funding, otherwise the program will go nowhere.

ACKNOWLEDGMENTS

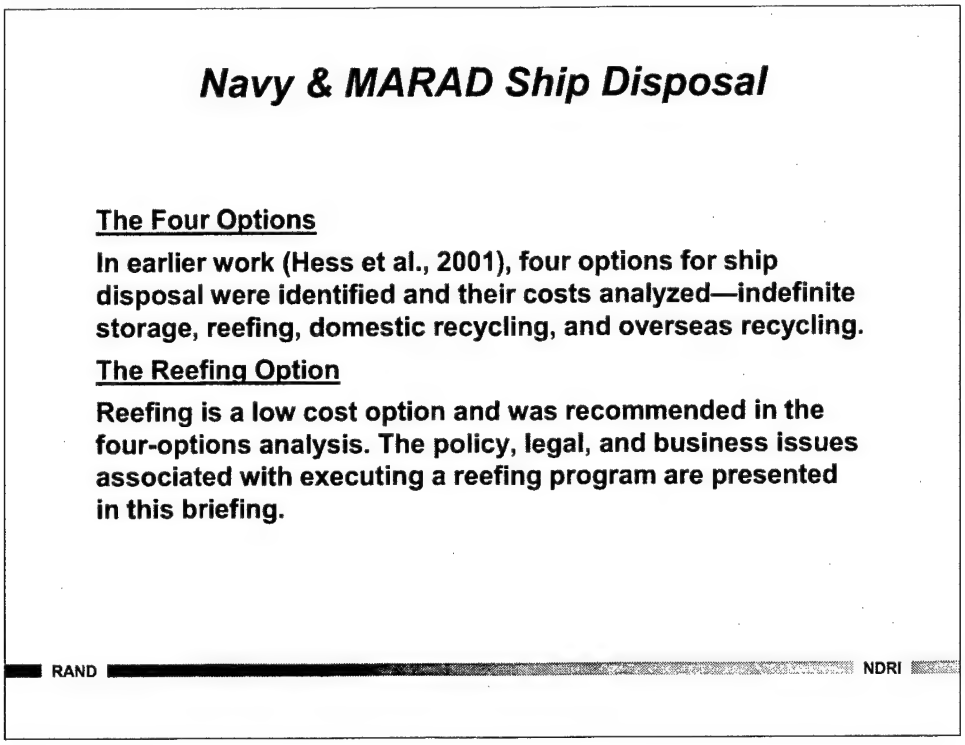
We would like to thank RADM Anthony W. Lengerich, USN, and Eugene Magee, of MARAD, for their help and support throughout the course of this project. Their aid in gathering critical data and providing access to important information was invaluable, and their comments on and insights into issues attending the inactive fleets, ship disposal, and similar matters enriched the project considerably.

We also want to acknowledge the staff and members of the Atlantic States Marine Fisheries Commission and the Gulf States Marine Fisheries Commission, particularly Mel Bell of South Carolina and Tom Maher of Florida; Dick Long of the San Diego Oceans Foundation; Jay Straith of the Artificial Reef Society of British Columbia; the National Steel and Shipbuilding Company; and the U.S. Coast Guard in the person of Nick Petagno and his teammates. All of these individuals made notable contributions to our understanding of the reefing option.

ACRONYMS

EIS	Environmental impact statement
EPA	[U.S.] Environmental Protection Agency
ES&H	Environmental, safety, and health
FGC	Federal-government corporation
FMS	Foreign military sales
FY	Fiscal year
GOCO	Government-owned, contractor-operated
GSMFC	Gulf States Marine Fisheries Commission
HMCS	Her Majesty's Canadian ship
IMO	International Maritime Organization
K	Thousand
LDC	London Dumping Convention
LSW	Light-ship weight
M	Million
MARAD	Maritime Administration
MOB	Mobilization [assets]
NASSCO	National Steel and Shipbuilding Company
NAVSEA	Naval Sea Systems Command
NFEA	National Fishing Enhancement Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations and maintenance
OPNAV	Office of the Chief of Naval Operations

PCB	Polychlorinated biphenyl
PSNS	Puget Sound Naval Shipyard
SDP	Ship Disposal Program
SFR	Sport Fish Restoration [Act]
SINKEX	Sinking exercise
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USNS	U.S. Navy Ship
USS	United States Ship

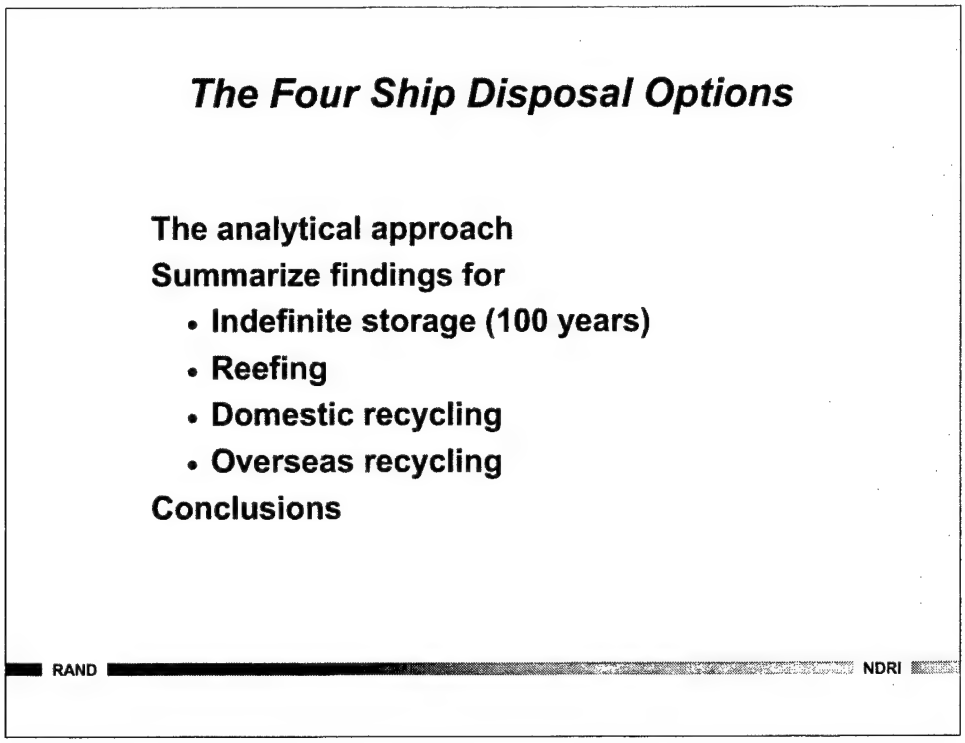


INTRODUCTION: NAVY AND MARITIME ADMINISTRATION SHIP DISPOSAL

In 2000, the U.S. Navy asked the RAND Corporation to explore disposal options for unneeded nonnuclear-powered Navy and Maritime Administration (MARAD) ships. Four options were evaluated in detail: (1) indefinite storage or the "do nothing" policy, (2) using the ships to build artificial reefs, (3) domestic recycling, and (4) overseas recycling.[1] RAND concluded that sinking ships to create artificial reefs (hereinafter, "reefing") was much less costly than indefinite storage or domestic scrapping of ships. In fact, reefing would, over the years the reefs functioned, return more tax money to state and federal governments than the cost to prepare and place the ships as reefs. RAND was subsequently asked to determine what policy actions would be required to create a government-funded reefing program as a reliable, low-cost, low-risk means for ship disposal.

[1] See Hess et al. (2001).

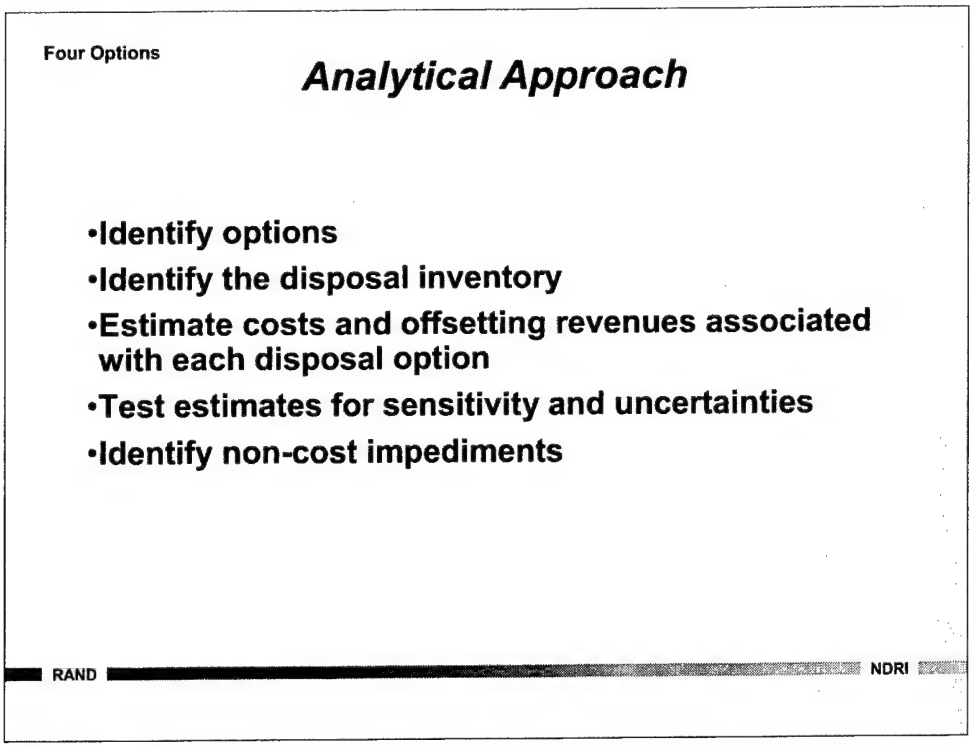
This briefing summarizes the result of that study so that the Navy can decide whether or not to examine a reef building program in more detail. In the next section of this briefing, we summarize the earlier research to explain how we concluded that reefing was a good option. In the final section of this briefing, we outline some of the considerations pertinent to developing an effective reefing program that would dispose of the ships.



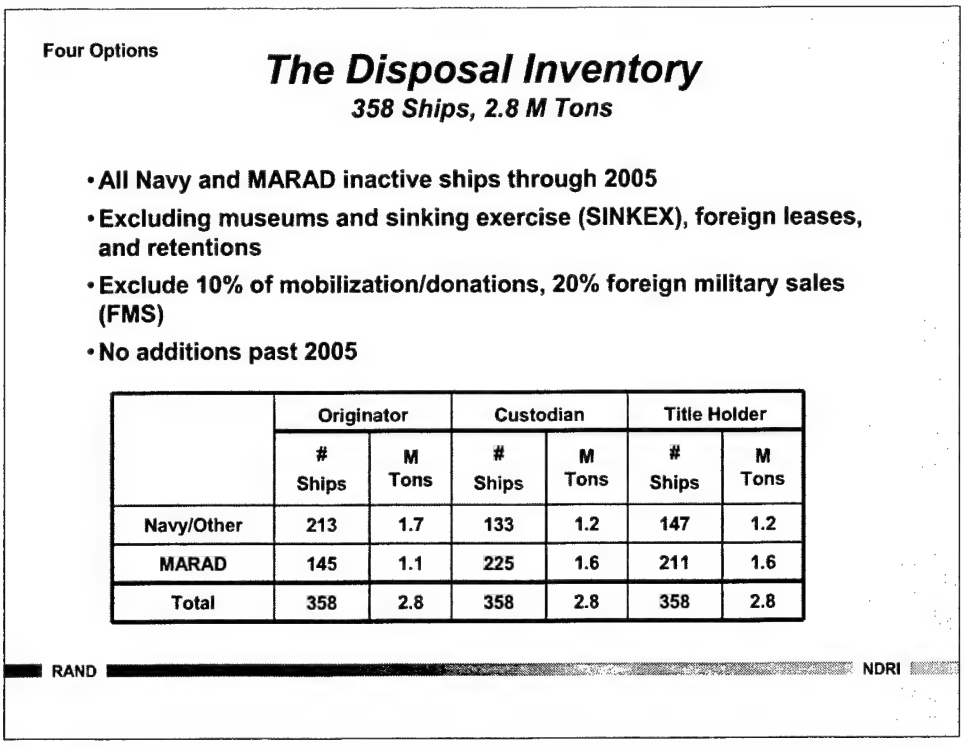
THE FOUR SHIP DISPOSAL OPTIONS

In this section of the briefing, we describe our analytical approach, summarize the findings on the four options, and present our conclusions.

Historically, unneeded ships were recycled (i.e., "scrapped") at a profit to the U.S. government, either domestically or overseas. Therefore, recycling domestically or recycling overseas are two obvious options for ship disposal. Indefinite storage is also realistic. A fourth option, reefing, has been done frequently since the early 1970s; hence, it was included in our study. There are other ways that Navy ships have been disposed of. There are about 80 ships serving as museums, and from time to time more are added. (Eventually, the Navy will get them back, however, for final disposal.) Some ships are sold overseas for continued use. Some are consumed in sinking exercises for fleet practice. Some are converted for an alternate use, such as for training. Other innovative uses occasionally arise, but the number of ships consumed for those uses is small. Only the first four options are realistic for disposing of hundreds of ships.



While considering options, we also set about to define the problem—just how many ships are there to dispose of? We then estimated all costs for each option, including interim storage while awaiting recycling and the cost to tow ships to their final destination. We then tested our cost estimates for various uncertainties, such as the cost of labor, and identified possible impediments aside from costs.



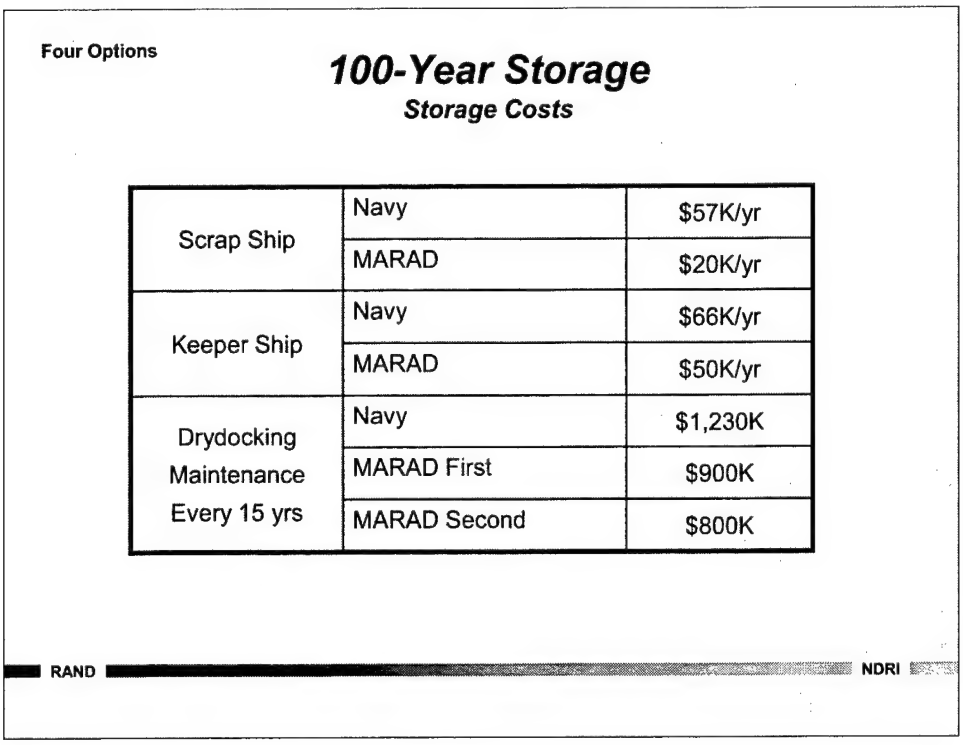
	Originator		Custodian		Title Holder	
	# Ships	M Tons	# Ships	M Tons	# Ships	M Tons
Navy/Other	213	1.7	133	1.2	147	1.2
MARAD	145	1.1	225	1.6	211	1.6
Total	358	2.8	358	2.8	358	2.8

To determine the number of ships involved, we took the Navy and MARAD inactive fleet lists as of late 1999 and added all the ships planned for inactivation through the year 2005, which was as far as specific disposal plans extended. We subtracted ships presently serving as museums or designated for sinking exercises, leased ships (all leases have been converted to final sales, no returns), and ships designated for indefinite retention, such as the battleships. We deleted 10 percent of the mobilization assets, i.e., ships retained for recommissioning in an emergency, because that is the percentage that historically has eventually been sold or leased to foreign governments. Finally, we subtracted 10 percent of the donation candidates and 20 percent of the sale candidates based on the historic record showing that this is the actual success rate. We were told by the Navy to assume that any inactivations beyond 2005 will be disposed of by sinking exercises, sales, or donations.

The result was 358 ships totaling 2.8 million displacement tons. This is more than is presently on the Navy and MARAD disposal lists because of the inclusion of further retirements through 2005. Since late 1999, 24 of these ships, totaling about 109,000 tons, have been recycled for a net cost to the government of about $65.5 million. While the total number of ships

is now down 7 percent, the tonnage is down only 4 percent because many of the recycled ships were quite small.

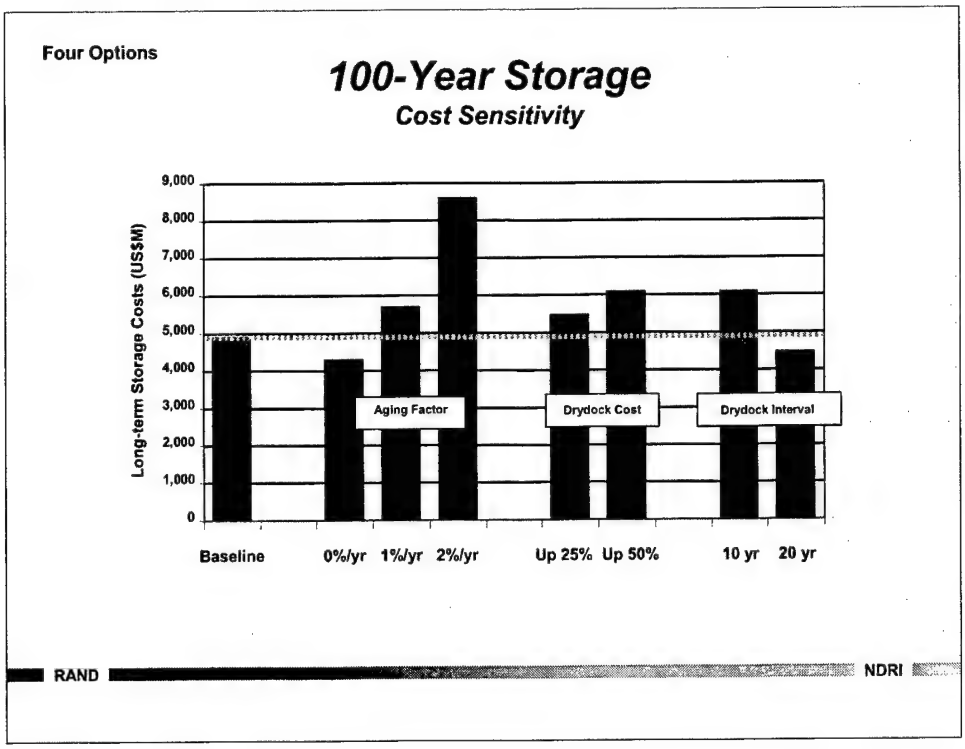
The table on the previous page displays the ships in three categories: the originator of the ship, the agency presently storing the ship (i.e., the custodian), and the agency holding title (i.e., the agency presently responsible for doing something). MARAD has picked up about 66 ships by title transfer from the Navy.



As mentioned earlier, one option is indefinite storage. We define "indefinite" as 100 years to highlight the need to undertake action beyond current scrap-ship storage practices if ships are to be kept indefinitely. Without maintenance and repairs, a thin-skinned surface ship will likely sink within 20 or 30 years because of the inexorable assault of seawater on the ship's structures. This "do-nothing" level of maintenance is what is currently practiced, and the associated storage cost per ship, is indicated by the "Scrap Ship" entry in the table above. (The averages presented here and all other costs we present are in constant, undiscounted fiscal year [FY] 2000 dollars, unless specified otherwise.) The Navy spends more than MARAD because it has higher overhead at its facilities to manage the spare parts and mobilization (MOB) programs.

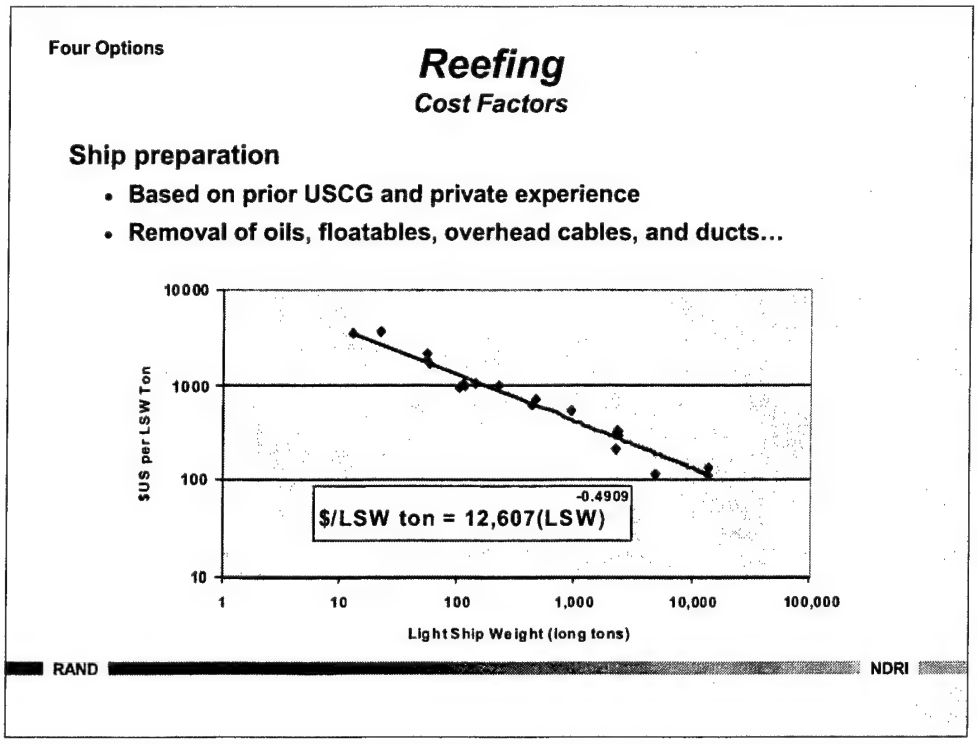
To keep a ship 100 years, we believe the "Keeper Ship" costs in the table are more appropriate than the scrap ship costs. These costs include dehumidification and cathodic protection to reduce hull corrosion. Beyond such annual costs, there will be the costs of drydocking, which we assume will occur every 15 years (see the third panel of the table). Drydocking cost estimates are from the Navy and MARAD; MARAD allowed more for a ship's first drydocking to remove any remaining fuel. We also assume that overall aging of the fleet will force up maintenance

costs by 0.5 percent per year. We have no firm basis for this estimate, so we vary it in our sensitivity analysis.



The left bar on the figure above shows the total cost in constant FY 2000 dollars for indefinite storage of 358 ships. The total is about $4.9 billion or about $49 million per year. This is more than the Navy and MARAD presently spend on scrap-ship storage. The chart also shows what happens to the total cost if some of our assumptions are incorrect. Aging of 0%, 1%, or 2% is shown. The zero-aging case does not change the total much, but at 2 percent the cost increases by about three-quarters. Changing the drydocking cost by plus 25 percent or plus 50 percent or the drydocking interval to 10 or 20 years also has minor effects as shown.

Our baseline cost assumes that both the Navy and MARAD will continue to store the unneeded ships in the same ratio as exists today. If all such ships were moved to MARAD facilities, the total baseline cost would drop to about $4.3 billion. But wherever they are stored, they remain at the end of the 100 years—a problem for our great-grandchildren to deal with.



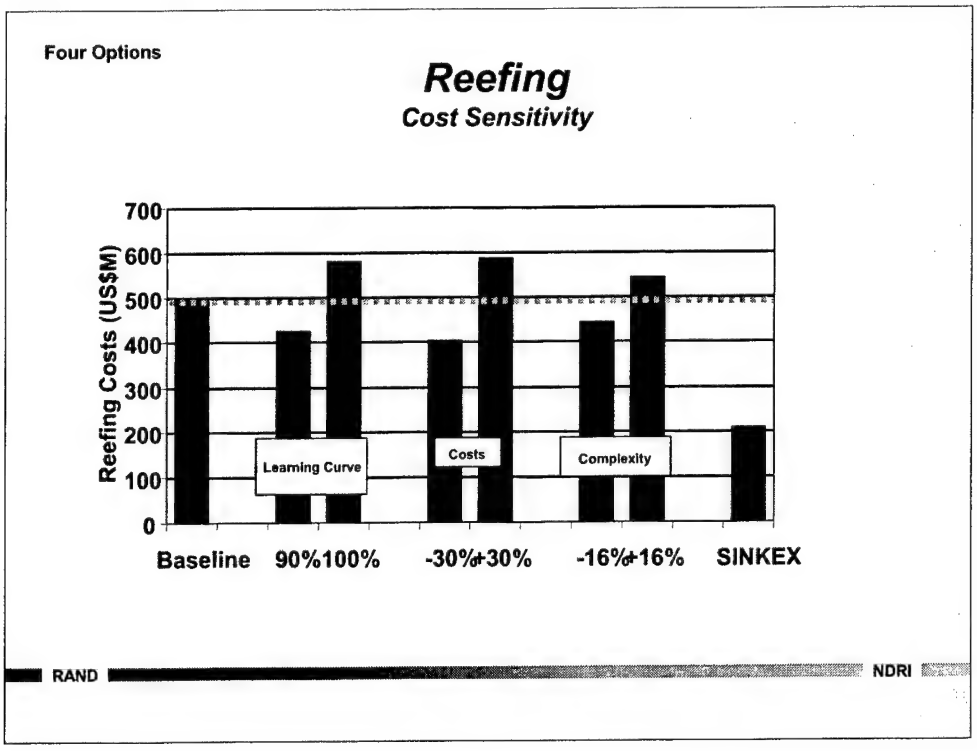
An *artificial reef* is anything placed on the near-shore sea bottom out to a depth of about 200 meters whose purpose is to stimulate fish production or (at near-shore depths) serve as an attraction to divers. Reefs stimulate fish production by providing shelter to fish or by multiplying the hard-surface attachment sites for benthic organisms that form the basis for food webs eventually contributing to fish production. Ships, including those sunk in accidents, may serve and have served as reefs.

To safely serve as reefs, however, ships must be prepared before they are sunk. Ships contain contaminants such as fuels, lubricants, and PCBs that must be removed. For safety reasons, ships sunk as diving reefs will have their overhead cableways, pipes, and ducts removed and their hatches and doors either removed or welded shut. Some reef projects include the addition of fish homes to encourage the growth of certain species. Each reef project is different.

But despite the differences in recent ship-reef projects, there is a striking consistency in their available cost data. The chart above shows all the ship-preparation cost data we have. The data for the small vessels at 1,000 light-ship weight (LSW) tons and less are from the U.S. Coast Guard (USCG), which routinely converts its unwanted ships to reefs. Above 1,000 tons, we have costs for preparing several 2,400-ton ex-HMCS (Her

Majesty's Canadian ship) for reefs off British Columbia and San Diego, an estimate for preparing a notional 5,000-ton ship courtesy of National Steel and Shipbuilding Company (NASSCO), and current estimates for preparing ex–U.S. Navy Ship (USNS) *Gen. Hoyte S. Vandenberg* for reefing—a project not yet completed.

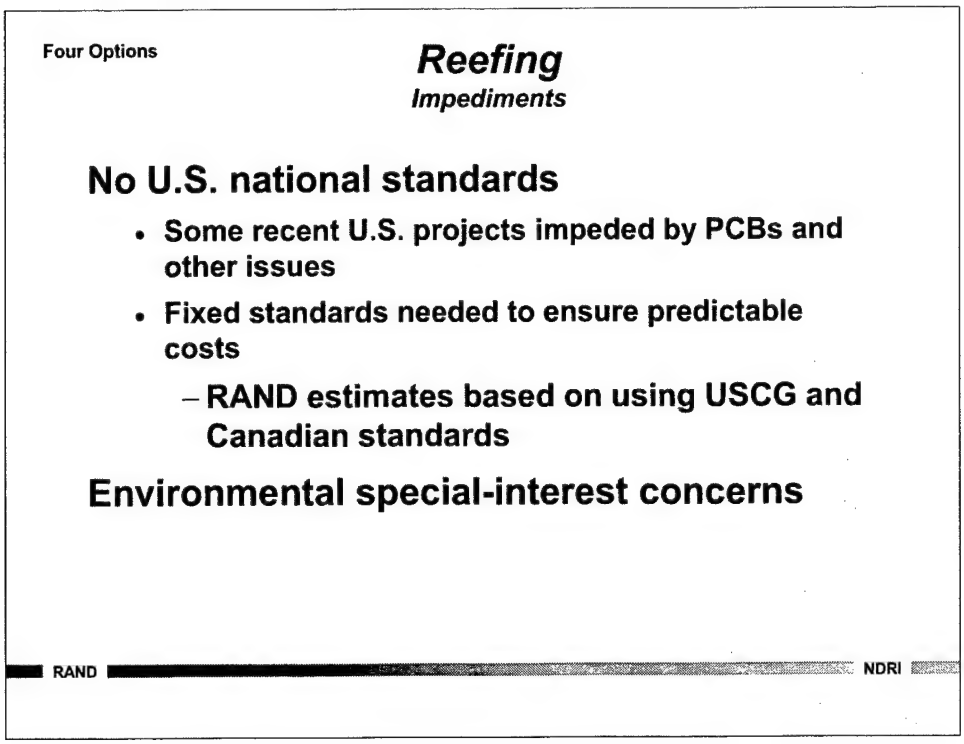
The data show a clear downward trend in per-ton costs apparently because of economy of scale. We use the equation representing this line for calculating the reefing preparation cost for the 358 ships. We then apply a 95 percent learning curve and add towing cost and interim storage cost.



Here are the results of a ship-preparation cost analysis.

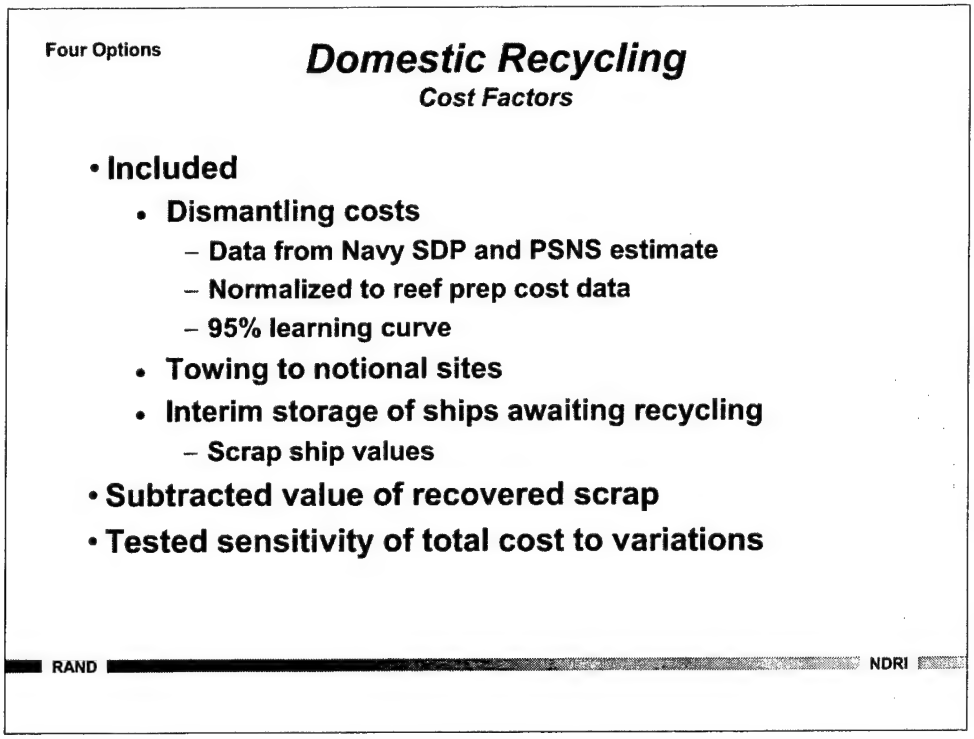
The left-most bar in the chart above shows the baseline case in constant FY 2000 dollars. It totals about $500 million (M) or about $25 million per year for 20 years. The chart also shows the effect of changing the learning curve and the labor cost. The third pair of bars reflects the 16 percent error band around the fit line on the preceding chart. We take this as reflecting the complexity of the project, as complexity could drive the variation in cost per ton at any given tonnage. The results are quite stable and always come out between $400M and $600M for the full program. The chart also shows that the Navy and MARAD would spend about $200M if all 358 ships were to be cleaned and used in sinking exercises (where the cleaning standard is lower than that for reefing) over the next 20 years.

What is not shown in the chart is that shallow-water artificial reefs (as opposed to deep-water sinking exercises) generate business revenue and jobs. We estimate enough tax revenues will be generated by a steady 20-year reefing program to cover all the costs by the 12th year.



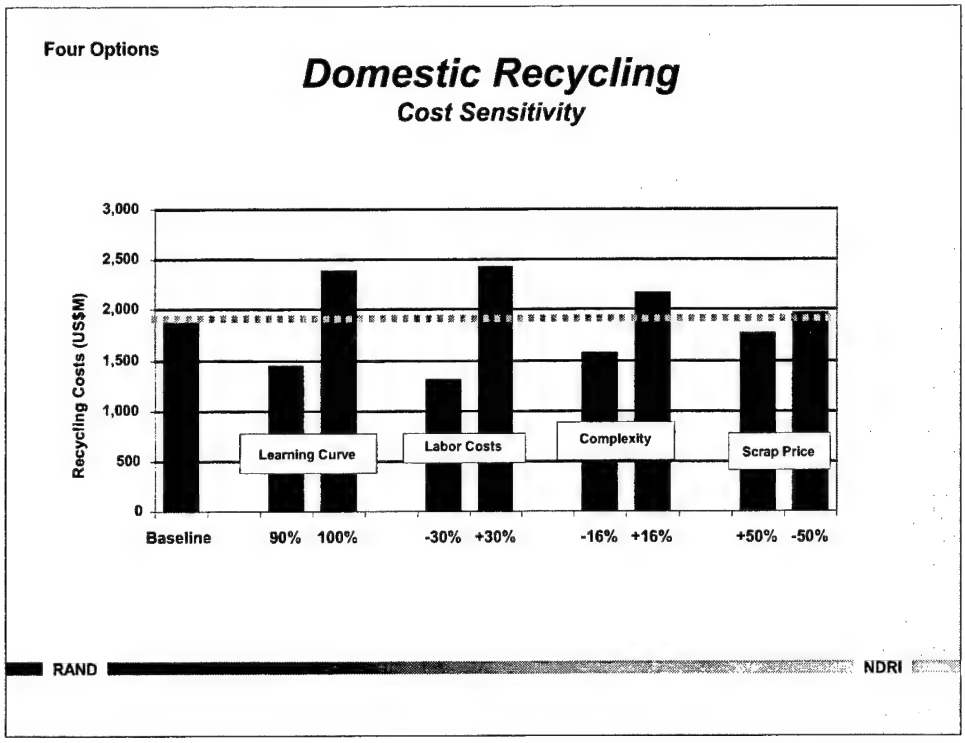
There are impediments to a reefing program. There are no national standards for preparing ships for reefs as there are for recycling ships. In recent years, ships have been prepared according to ad hoc local and regional standards, which has complicated the reefing process. For example, the recent use of the ex-HMCS *Yukon* for a reef off San Diego was based on Canadian standards amended by California authorities. National standards are needed to smooth the way.

Some environmentalists have expressed reservations about artificial reefs—they may grow more fish, but the fish are so easy to catch that the net effect is negative. We have found little support for that theory so far.



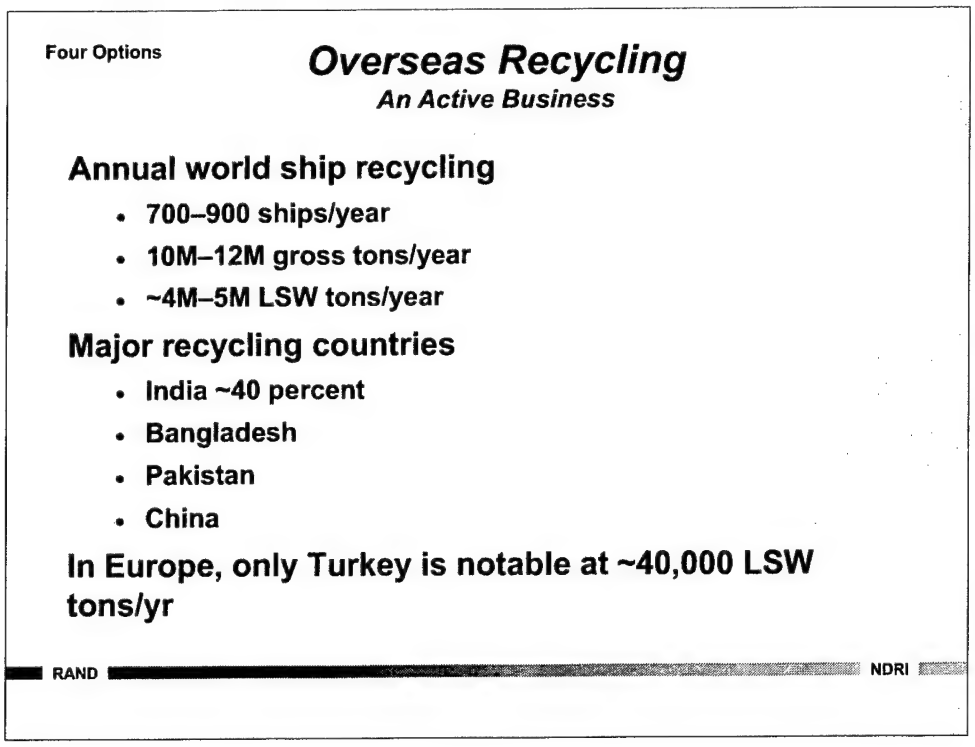
Domestic recycling is one way the Navy now disposes of ships. To estimate the cost of the domestic recycling option, we gathered information available at the time of data collection (early 2000) from the Navy Ship Disposal Program (SDP) and from the Puget Sound Naval Shipyard (PSNS). These sources provided us with an estimate for recycling a notional 5,000-ton non-nuclear surface ship. We averaged these data together and came up with $1,400 per ton for a 3,600-ton ship. We then renormalized the reefing cost figure shown earlier so that the line in the "Reefing Cost Factors" chart passed through the $1,400/3,600-ton point and used the resulting equation to estimate dismantling costs for recycling all 358 ships. We tried other means to estimate the total dismantling cost, but we chose the adjusted ship-preparation graph because it had the best foundation.

We then added costs for towing from storage to four notional recycling sites, one on the West Coast, one on the Gulf Coast, and two on the East Coast. We added interim storage costs and applied a 95 percent learning curve to the dismantling cost. We subtracted the estimated value of the recovered scrap metal and parts and tested the sensitivity of the results to variations.



Here are the results of the domestic recycling cost analysis. The left-most bar is the baseline case at a total cost of $1.9 billion or about $95 million per year for 20 years. The next three sets of bars show the effect of varying the learning curve, labor costs, and the "complexity factor" mentioned earlier. These variations can individually cause the total program cost to vary up or down by about one-quarter to one-half billion dollars. Note the far-right set of bars. It shows the effect of varying the value of scrap metal by 50 percent. The effect is very small.

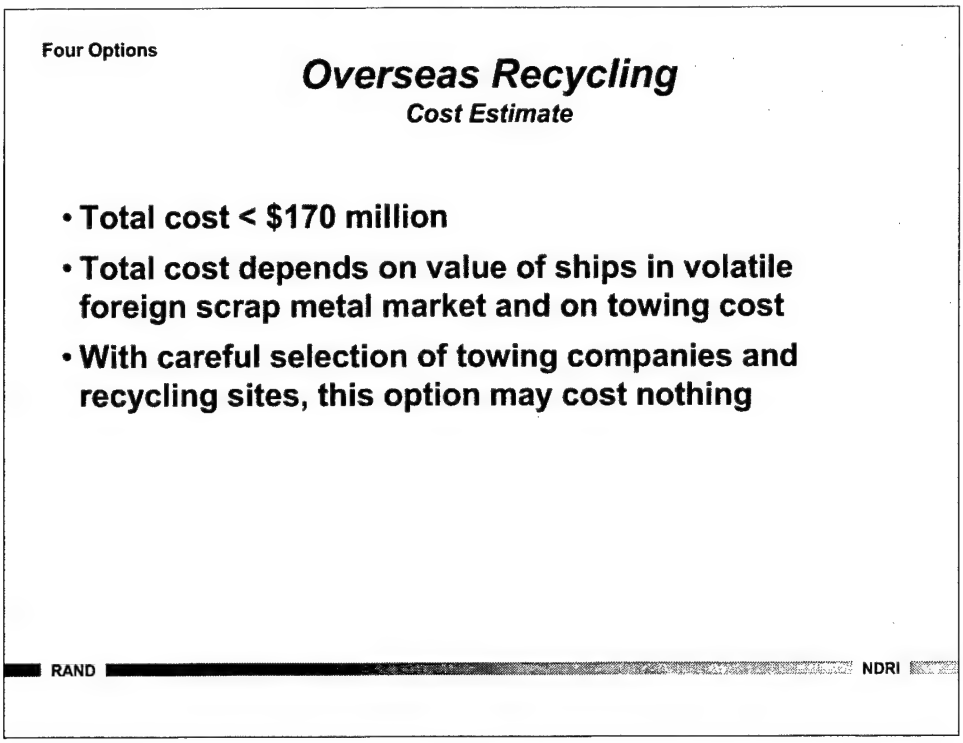
We have reviewed recent returns from the Navy and MARAD ship-recycling programs to see how our original estimates are holding up. Overall, 24 ships totaling 109,000 tons have been recycled for a gross dismantling cost of about $75 million. Our original model would estimate about $120 million gross dismantling cost for these ships, so the program appears to be working more efficiently than we assumed. However, the lower costs are not low enough to reverse our conclusion that domestic recycling is not an attractive disposal option.



Ship recycling is an active part of the world shipping business. When the cost of ship maintenance approaches the value of a merchant ship on the scrapping market, the owner will sell it for scrap and build new. This typically occurs around the 25-year point. Hundreds of ships per year adding to several million LSW tons are recycled each year, mostly in India, Pakistan, Bangladesh, and communist China. Among European nations, only Turkey has a notable recycling industry. But it is small—about 40,000 tons per year.

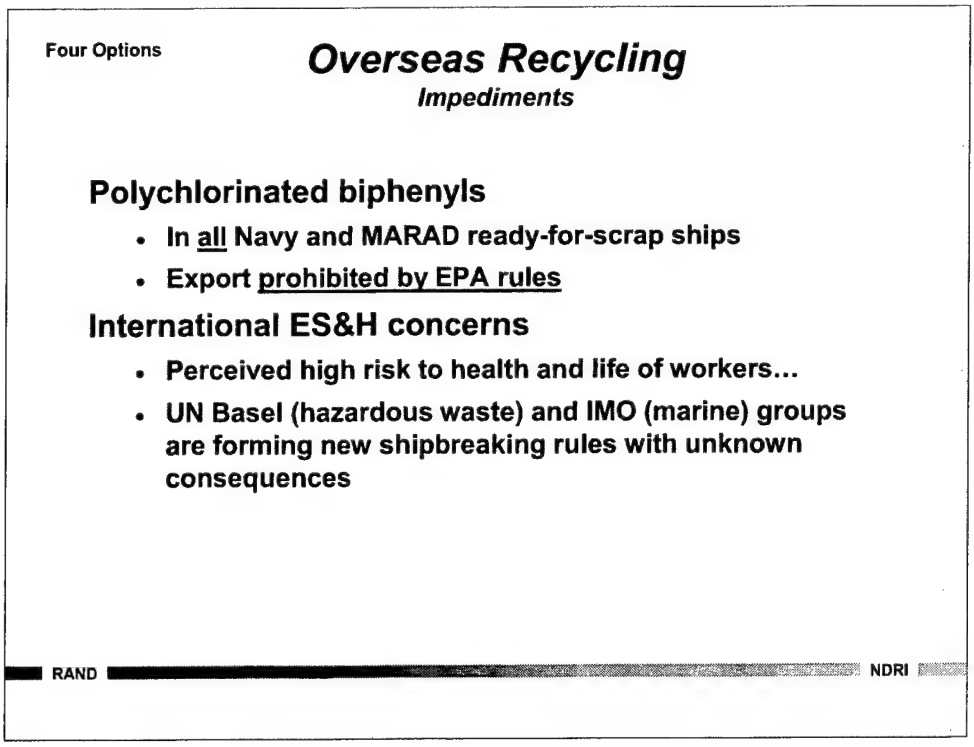
Asian ship recycling remains viable because of very low labor costs and minimal environmental, safety, and health (ES&H) regulations. A worker at Alang, India, may make $4 per day with very little burdened cost, while a U.S. semi-skilled worker has a burdened cost of $160 to $320 per day.

The cost estimate for this option includes interim storage plus towing cost less the value of the ship on the overseas market—typically $50 to $150 per LSW ton. (We assumed a five-year program, meaning 72 ships would be towed per year, so towboat availability should not be a problem.)



We estimated the total cost for an overseas recycling program at $170 million. However, our cost model was dominated by towing, and we assumed one ship would be towed at a time. Towing two at a time would drastically reduce the cost, perhaps to zero. In practice, the Navy and MARAD would probably make money on the large ships, such as aircraft carriers, landing ships, and big merchant ships, and lose money on destroyers, frigates, and other smaller vessels, coming out about even in the end.

But there are problems with this option.

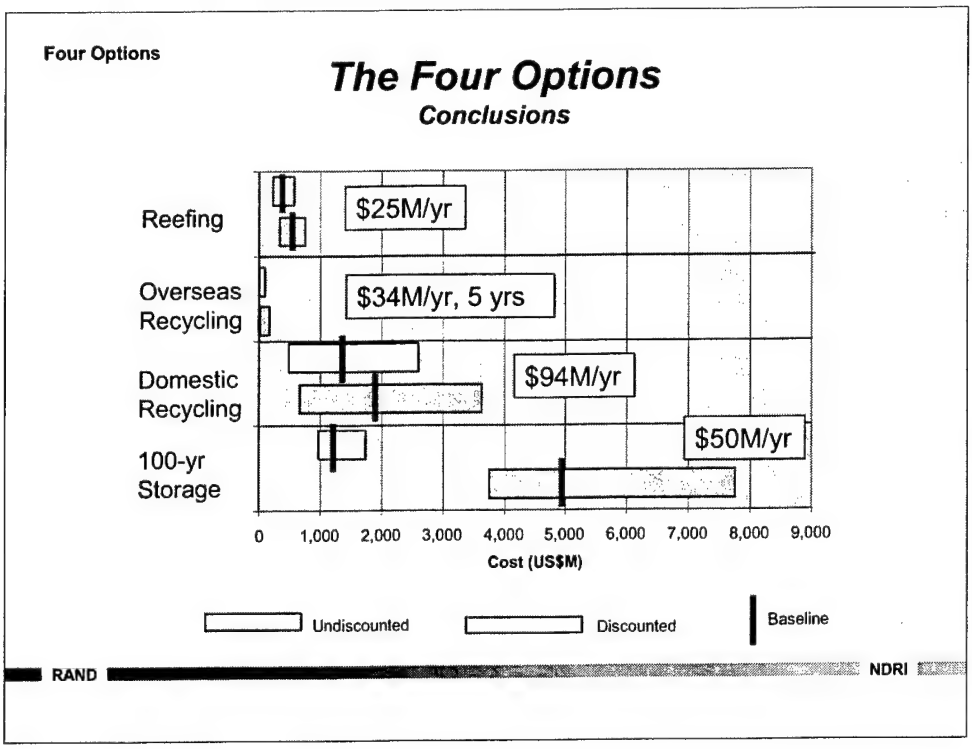


All of the ready-for-recycle ships in the inventory have polychlorinated biphenyls (PCBs) aboard, and it is likely that all ships that become ready in the next decade will also. Current U.S. Environmental Protection Agency (EPA) rules prohibit the export of anything containing more than 2 parts per million PCBs. Sampling could be done to find the PCB-free ships, but it would be expensive (about $100 per sample) and, in all likelihood, no such ships would be found. The EPA rule makes overseas recycling essentially impossible.

There are also international ES&H concerns at overseas recycling yards. These yards have been criticized by environmental groups. As a result, the United Nations Basel Convention on the Transboundary Movement of Hazardous Wastes and the International Maritime Organization (IMO) are considering new international rules restricting what can be aboard ships being offered for recycling. MARAD serves on the committees working on these issues. We do not know how these issues will be resolved.

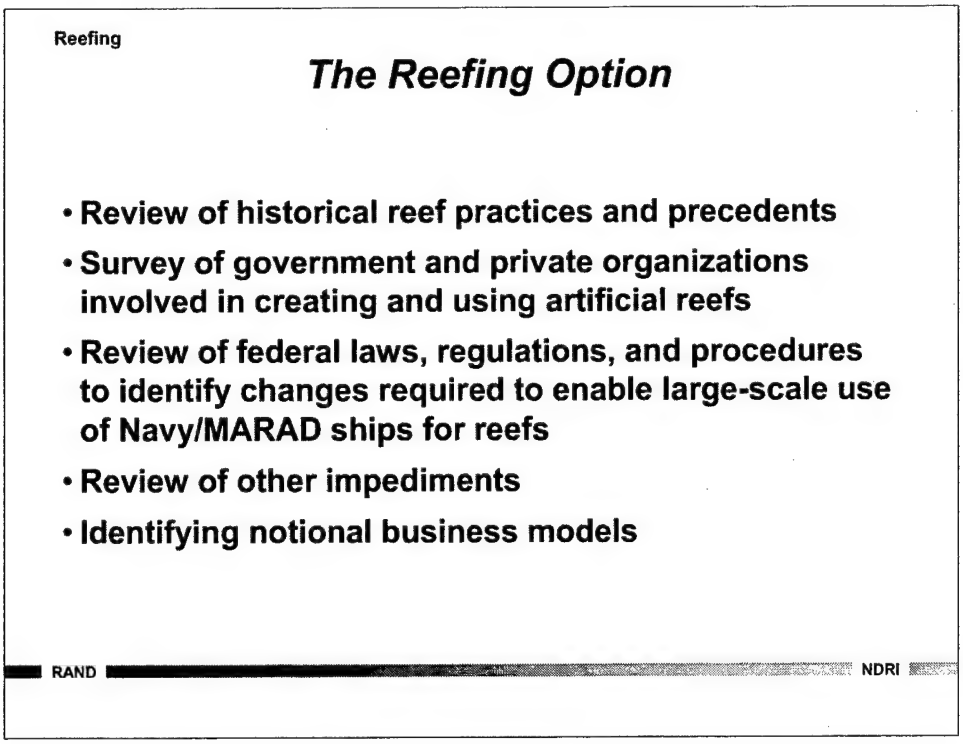
In sum, the current EPA rules effectively prohibit export of ships for recycling, and political sensitivities make it inadvisable. (These impediments are much more serious than those facing reefing, which involves less work on the ship, and because that work would be done in

the United States, there are fewer ES&H concerns. A blanket EPA exception for ship recycling is highly unlikely.)



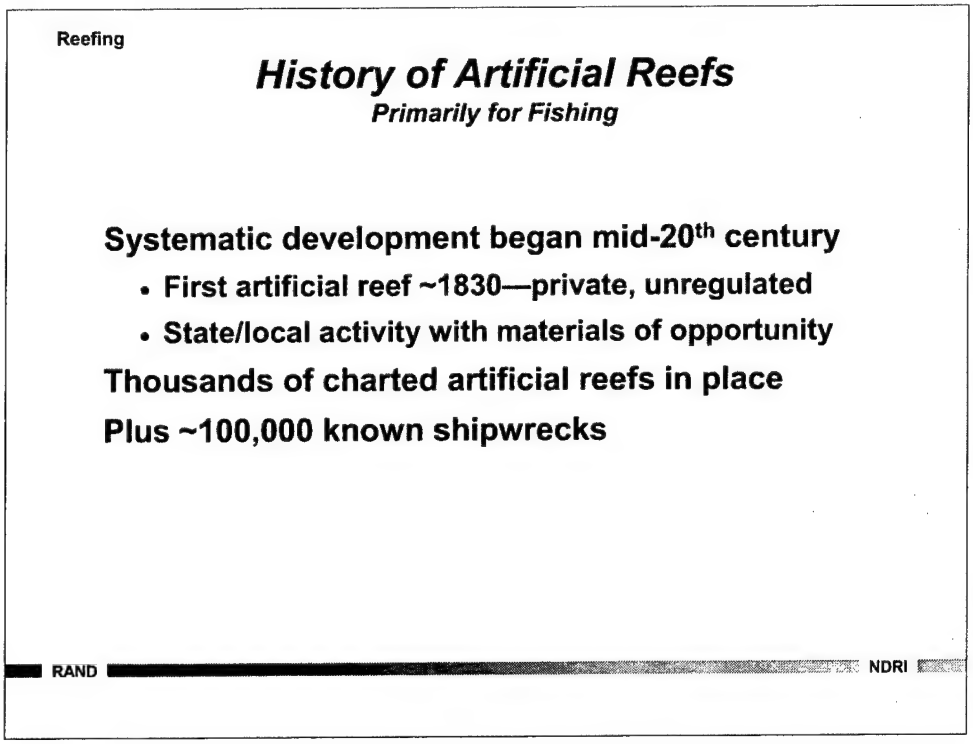
This chart summarizes the costs of the four options. The crosshatched band is bounded by the undiscounted sums of all high and low variations we considered for each option, and the vertical bar within each band is the baseline cost. The lighter bands show analogous discounted costs. The figures in the boxes are the average annual baseline costs.

Because overseas recycling is barred by U.S. regulations, reefing is left as the least-expensive option. But, as we will show, it will actually be a moneymaker. We now address the reefing possibility in more detail.



EXAMINING THE REEFING OPTION

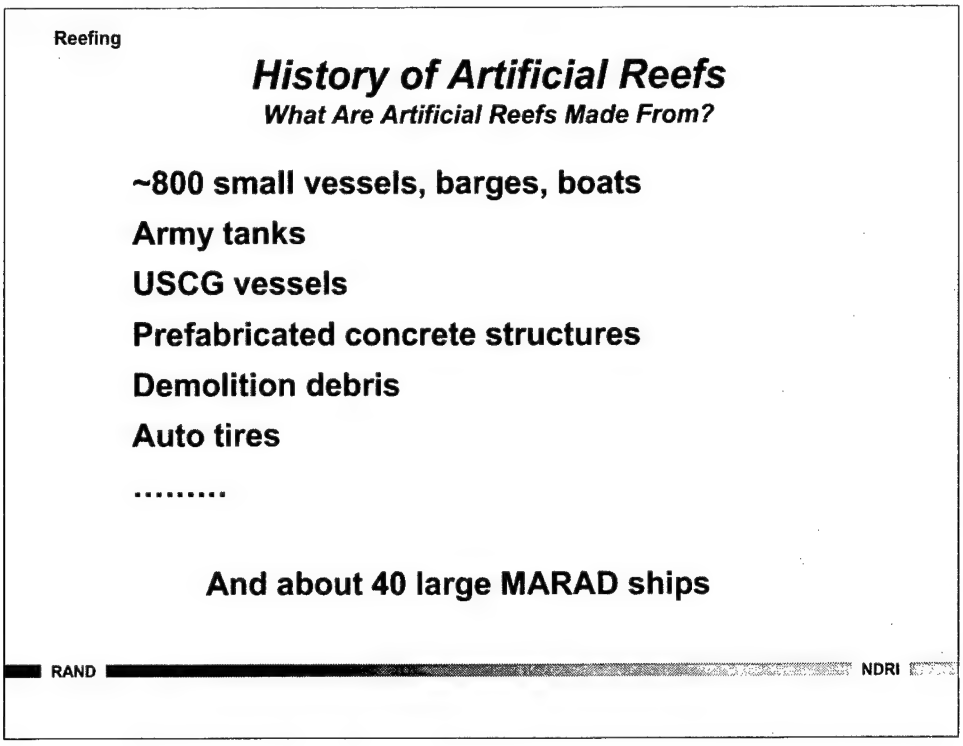
As we discuss in this section of the briefing, we reviewed reef-building history in detail to determine current practices and how they might fit into a larger-scale reef program using Navy and MARAD ships. We conducted formal written surveys and made several personal contacts with key reef-building interests to determine how they presently perceive the use of ships as reefs and what it would take to encourage greater use. We have reviewed federal laws, regulations, and procedures to determine which of them must be changed to permit large-scale use of ships and what new laws might be needed. We have looked for impediments to such a program, and we have begun to explore possible business models.



Artificial reefs have been built off U.S. coasts for more than 170 years but only since the 1970s has the practice acquired popularity. There are now more than 800 vessels placed as artificial reefs. Except for about 40 Liberty and Victory ships, all are small vessels less than 200 feet long.

Reef building is primarily a fisheries-based state and regional function, although there are several federal acts that have attempted to facilitate the process. The so-called Liberty Ship Act of 1972 made MARAD ships available to the states for reefs, as long as no costs accrued to the federal government. The National Fishing Enhancement Act of 1984 permits oil rigs to be left in place as fishing reefs. We will say more about these acts later. Federal excise taxes and state fishing license charges fund some reef building, but at a low level. Most of the costs are covered by private organizations and small state or local contributions.

All told, there are thousands of artificial reefs off U.S. coasts, along with at least 100,000 ships sunk by acts of man or nature. It is unclear how many of these ships are also functioning reefs; our point here is simply that artificial reefs are not uncommon.



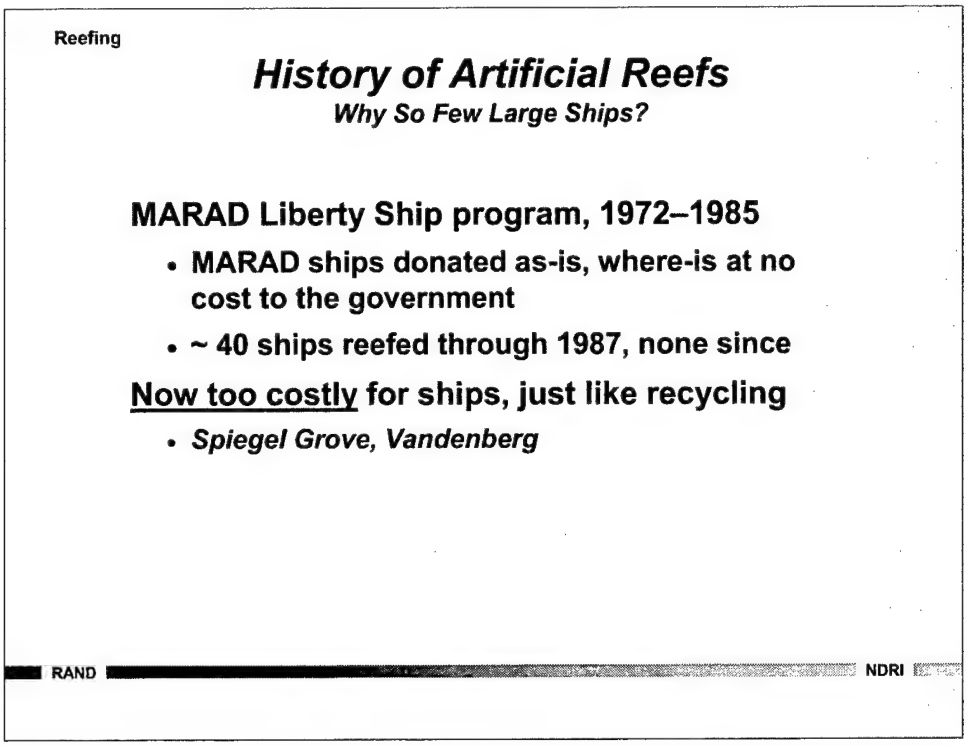
Artificial reefs have been made from nearly anything that will sink. Current rules promulgated by the Army Corps of Engineers limit materials to steel, concrete, and other substantial products that will sit firmly on the ocean bottom. The Army disposed of dozens of old tanks in the 1990s by cleaning them and donating them for reefs. The U.S. Coast Guard routinely disposes of old vessels by cleaning them in their Baltimore yard and donating them for reefs because it is less costly than scrapping them. About 16 ships have been disposed of in this way, and an equal number are in process. The largest of these ships displaces about 900 tons.

Within the past ten years, many forms of fabricated structures have been tried, including hollow "reef balls" and concrete culverts. Building and bridge demolition debris are also common.

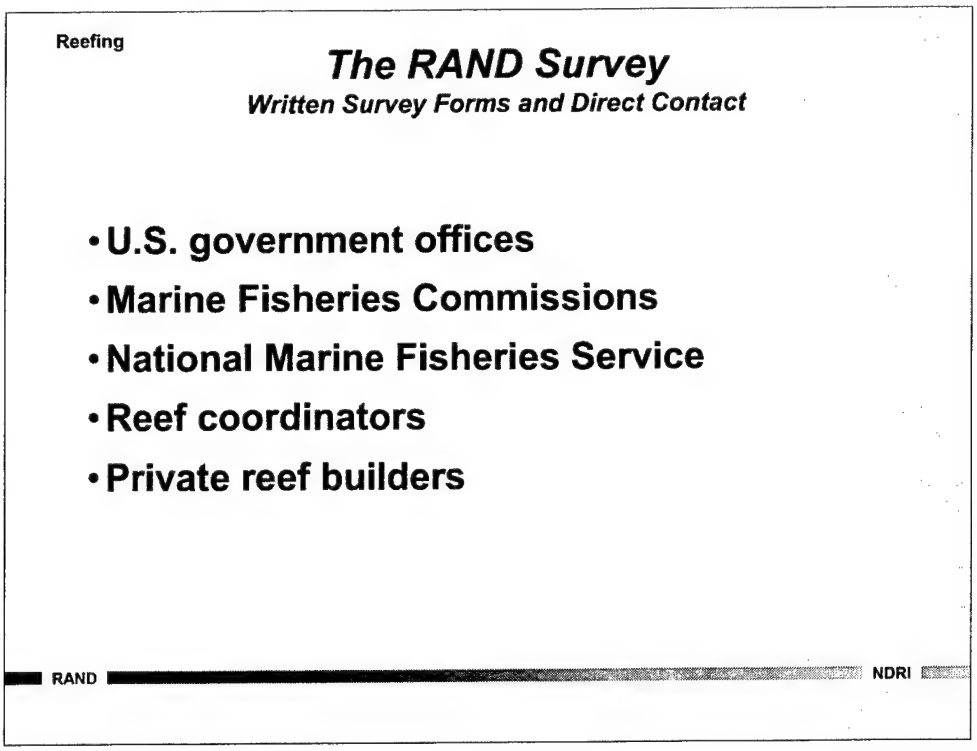
Evaluation of materials for building artificial reefs is a newly salient endeavor because of the potential effect of reef building on fisheries. Only in recent years have fisheries been the focus of much attention, following their national and worldwide decline. However, the National Reef Plan and all of the state plans that we have reviewed cite steel-hulled vessels as among the preferred materials because they will stay where they are sunk

(as opposed, for example, to fiberglass-hulled vessels, which deteriorate more rapidly).

The Liberty Ship program of 1972, amended in 1985 to include all MARAD ships, permitted the states to request a ship donation from MARAD to sink the ship for a reef. The donation is on an as-is, where-is basis at no cost to the federal government. About 40 ships were converted to reefs in this manner.

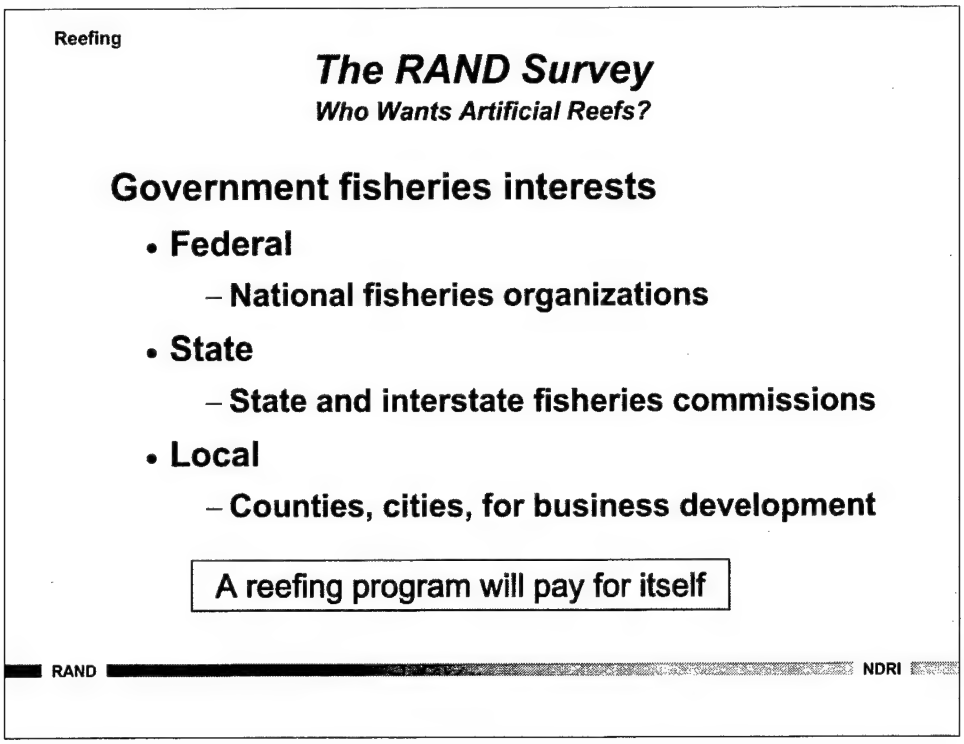


By 1987, the cost to prepare large ships for reefs had become too high for state, local, and private funding, so the program nearly ceased. The ex-USS *Spiegel Grove* is a case in point. This is a former Navy ship, transferred to MARAD several years ago, and made available for donation as a reef project. The ship has been the target of a privately funded Key Largo Florida reef-building project for more than five years. Funding has been very difficult to raise, and the project remains underfunded, although Florida has formally accepted title. Conversion of the *Vandenberg* to a reef off Key West is also privately funded and somewhat behind the *Spiegel Grove*. These are the only large ships drawn from the MARAD donations program for reefs in the past ten years.



We used written surveys and direct contacts to gather information from organizations and individuals, including the following:

1. The EPA, the U.S. Navy Office of General Counsel, the U.S. Army Corps of Engineers (USACE), and the U.S. Coast Guard.
2. The Atlantic and Gulf States Marine Fisheries Commissions. These commissions are responsible for developing and maintaining fisheries to the three-mile limit.
3. The National Marine Fisheries Service, which, together with regional fishery management councils, are responsible for developing and maintaining U.S. fisheries from 3 miles to 200 miles from shore.
4. State and local reef coordinators. These individuals have responsibility for local fisheries' activities inside the three-mile limit.
5. Several individuals and private organizations engaged in building artificial reefs, such as Artificial Reefs for the Keys and Project *Yukon*.

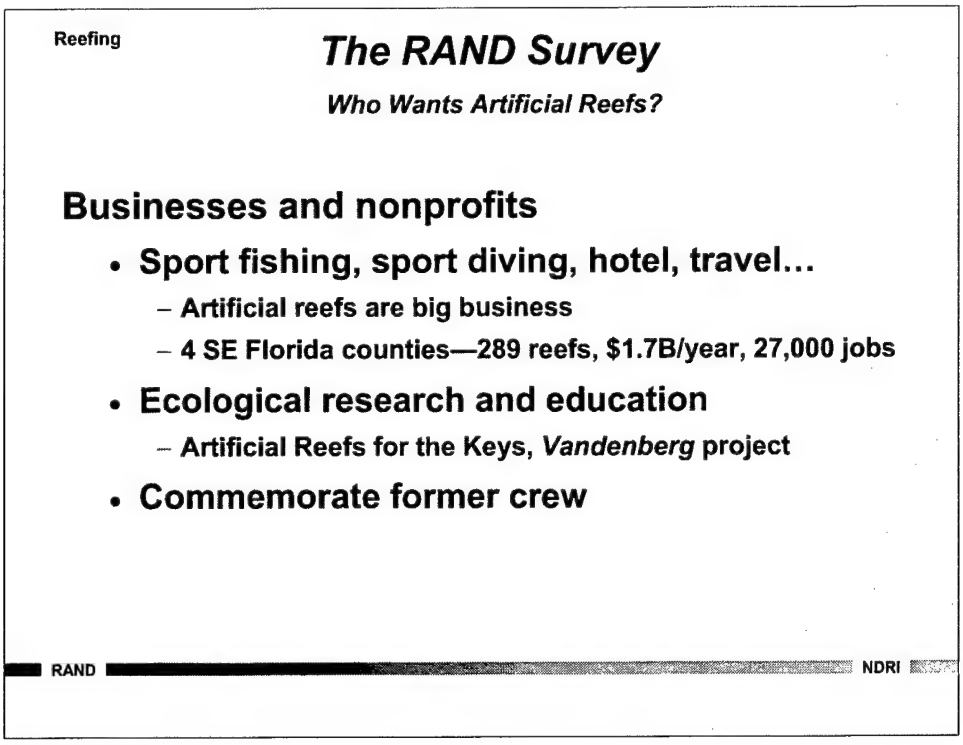


Building artificial reefs is a very balkanized process with involvement at nearly every level of government. At the federal level is the National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA), and the eight regionally oriented Fisheries Councils under its wing. Recent concern for the decline in our national fisheries may lead to federal interest for construction of large artificial reefs in relatively deep coastal waters.

Many states desire large ships because of the ships' economic and fisheries benefits. Many local governments want reefs because they provide jobs and tax revenues. An economic study of the artificial reefs off four southeastern Florida counties was completed in October 2002. It found that each reef generates $6M per year in business revenue and provides 100 jobs. Other studies show about $2.5M per year per reef in business revenues. If 25 percent of the revenue from new reefs comes to the government as taxes, a 20-year reefing program will have paid for itself by the 12th year.

SCUBA and snorkel diving is a growing industry and represents up to half of the business a shallow-water reef generates. But all of the government involvement in reefs arises because of concerns about

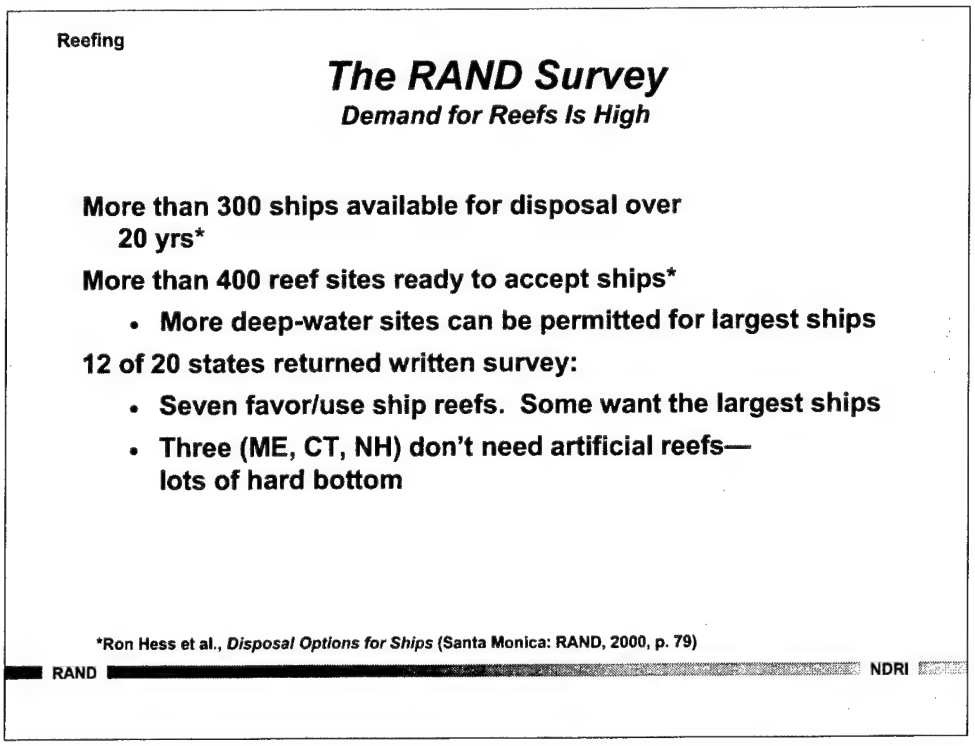
fisheries. There is no government advocate for recreational diving interests.



The local business community is an important advocate of artificial reefs because of the business opportunities they generate.

Sometimes, ecological and education interests take center stage in reef-build efforts. For example, the *Vandenberg* project is being advanced by Artificial Reefs for the Keys to promote these interests. There also may be interest in using ships to memorialize crew members.

Commercial fishermen are not publicly seen as advocates and rarely seen as users of reefs, probably because all reef-building activity so far has been limited with respect to commercial needs.



There are more than 300 Navy and MARAD ships that a reef-building program would have to handle over a score of years, and there appears to be adequate demand for many or perhaps all of those ships. In a recent survey, Atlantic and Gulf Coast state reef authorities reported that more than 846 steel vessels have been used for reefs over the past 25 years—and there is near-term demand for hundreds more.[2] In fact, there are at least 400 sites ready to accept ships, and more can be created if the ships are available. Most vessels used to date, however, have been small and from private sources.

There are 23 coastal states. Twelve of those states returned our written survey. Seven of the 12 already use ships as reefs or favor their use. Florida said it could use 25 ships, or even aircraft carriers, over the next few years. Some New England states say they do not want ships for reefs because they have plenty of natural reefs and a short fishing season.

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[2] Mel Bell, South Carolina Department of Natural Resources, personal communication, summer 2000.

Some reef advocates want large numbers of ships for fish propagation. South Carolina has suggested that a few dozen ships sunk 400 feet would help regenerate a depleted grouper population.

This interest in reefing does not come free of concerns. For example, the Florida Fish and Wildlife Conservation Commission is now considering what the commission policy should be with regard to extensive use of large government vessels as reefs, particularly in marine sanctuaries.[3] Matters of diver safety, state liability, cost, and coordination are also of interest to the states.

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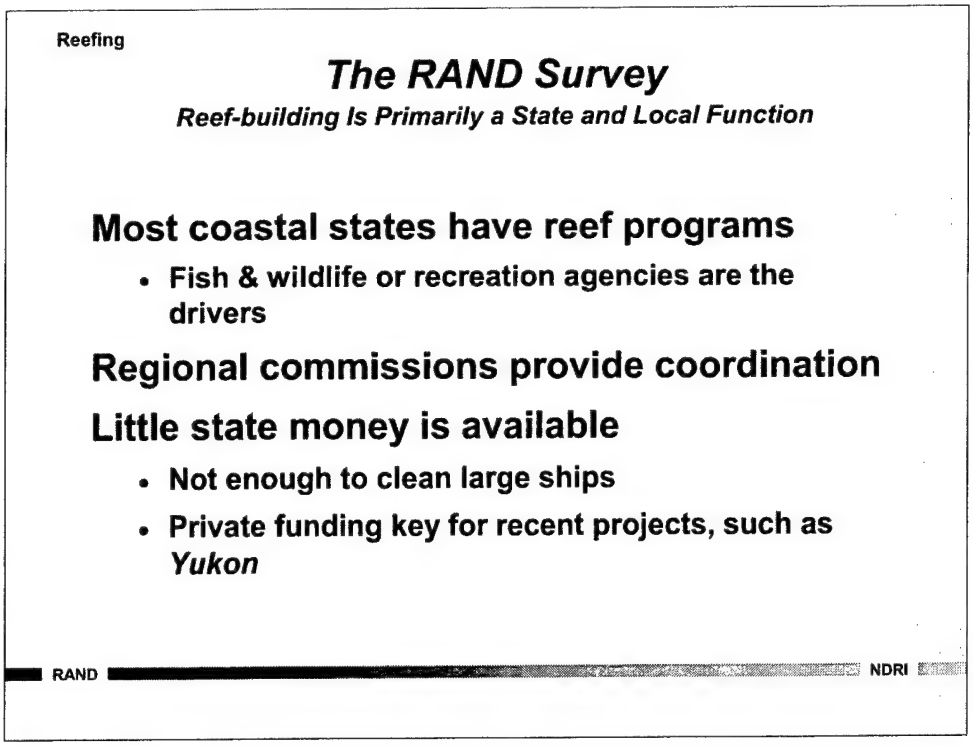
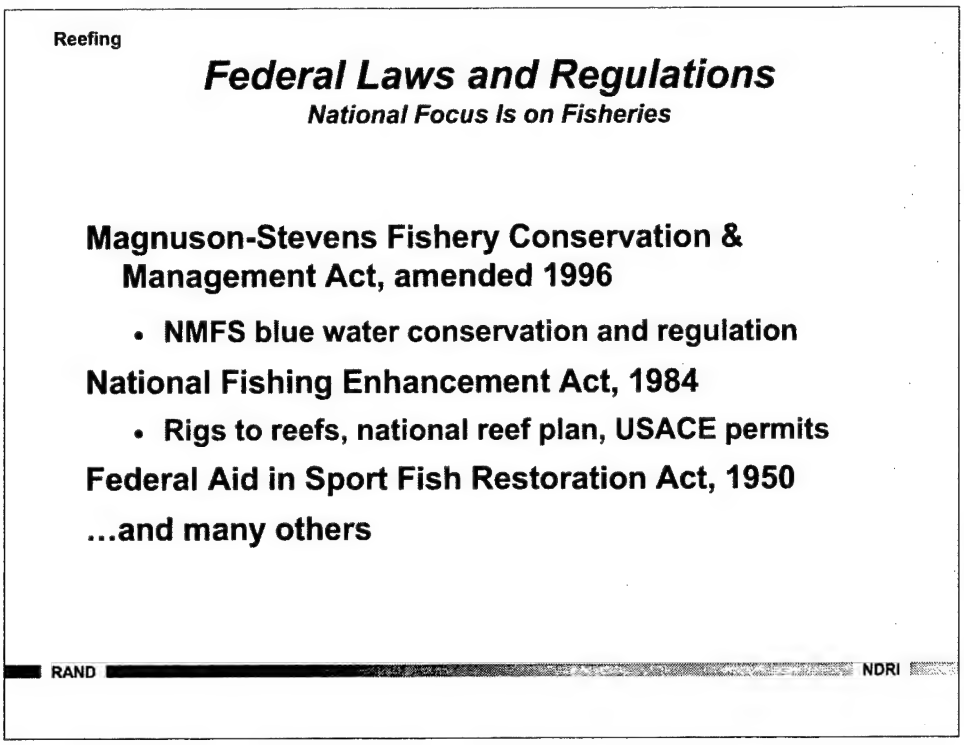
[3] Thomas Maher, Florida Fish and Wildlife Conservation Commission, private communication, various dates.



Most states have a reefing program overseen by a department of natural resources or department of fish and wildlife. Most states have reef management plans at the state level and state construction guidelines. Typically, though, states have no more than a few dozen artificial reefs, most of them in less than 100 feet of water. Recreational fishing and diving and stock enhancement of habitat and fisheries are the typical purposes.

A successful ships-to-reefs program must involve state and local governments and the regional fisheries commissions to ensure that the program is properly coordinated. But the Navy and MARAD cannot deal with a multitude of localities, so the focus would have to be on the states if the program is to be workable. However, reef building at the state level is not funded enough at this time to pay for cleaning large ships, and private funding is uncertain and spotty.



A large number of federal laws promote development and regulation of coastal fisheries. Three laws are key:

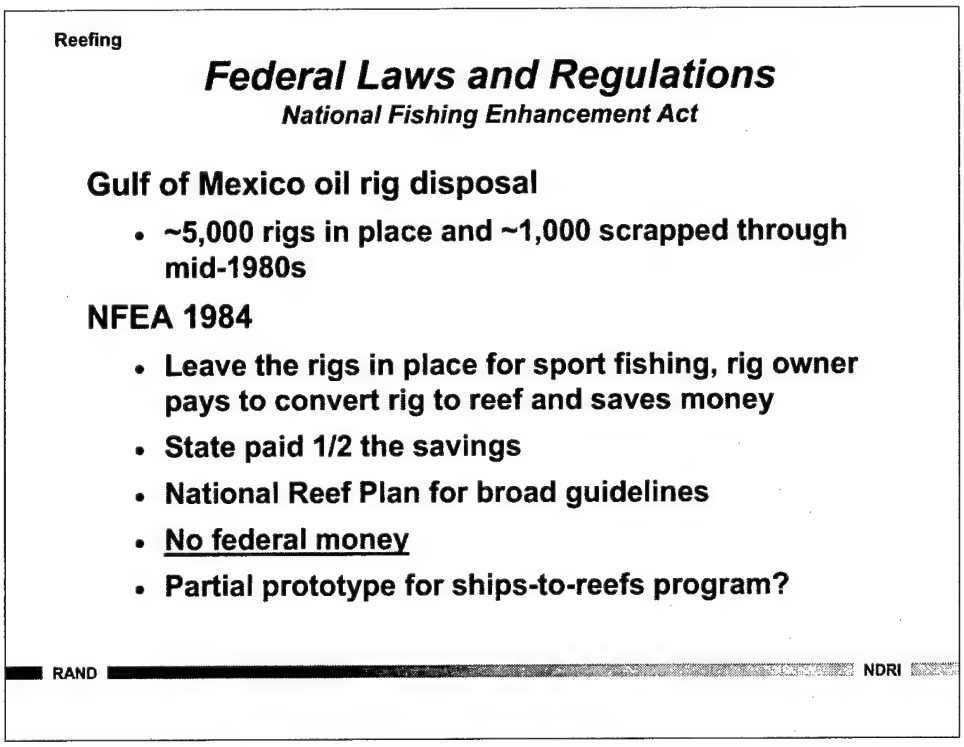
The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801) defines the duties of the National Marine Fisheries Service in NOAA. This is the organization that might be interested in large offshore fish restoration projects, such as the South Carolina grouper nursery mentioned earlier.

The National Fishing Enhancement Act of 1984 (33 U.S.C. 2101) focused on artificial reefs at the national level. It set up a program for converting oil rigs to reefs. This act may serve as a prototype for the technical aspects of a ships-to-reefs program.

The Federal Aid in Sport Fish Restoration Act of 1950 (16 U.S.C. 777) is the legal engine for collecting and disbursing excise taxes on fishing equipment to support fishing enhancement projects. About $400M per year is collected and disbursed under this program. Because the primary users of ship reefs are sport fishermen, it is feasible that this funding source could be used for a ships-to-reefs program.

The permitting process for reefs is under the Army Corps of Engineers and USACE's authority under the Rivers and Harbors Act and the Outer

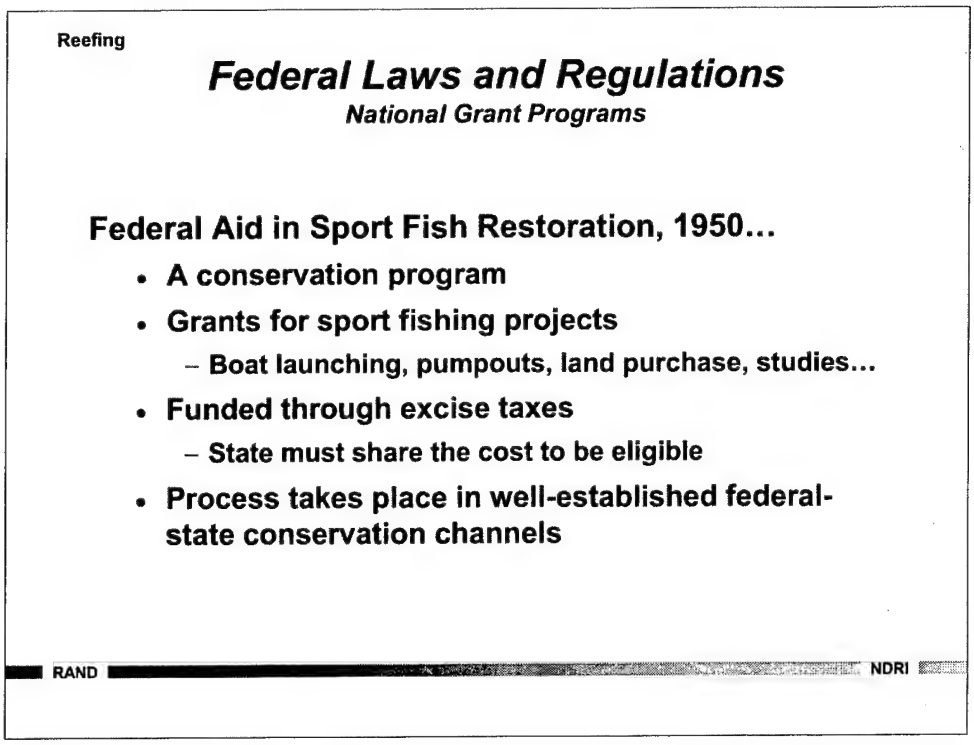
Continental Shelf Lands Act. Under this authority, the USACE issues permits for reefs to ensure that there are no impediments to navigation. The Corps's process is straightforward and appears adequate to support a ships-to-reefs program.



About 5,000 oil rigs have been erected in the Gulf of Mexico over the years, and about 1,000 obsolete ones were removed by their owners through the mid-1980s. However, removing the rigs also removed favorite fishing sites, leading to complaints from sport fishermen; consequently the National Fishing Enhancement Act (NFEA) was enacted. NFEA allows rigs to be left in place. The tops are often cut off below the waterline and sunk nearby. NFEA requires the adjacent state to be given half of the money the owner saves by not having to recycle the whole rig. The oil company saves money, the state gets money, and sport fishermen are happy. While no federal money is involved in NFEA, it represents a precedent for a federally permitted large-scale reef building program.

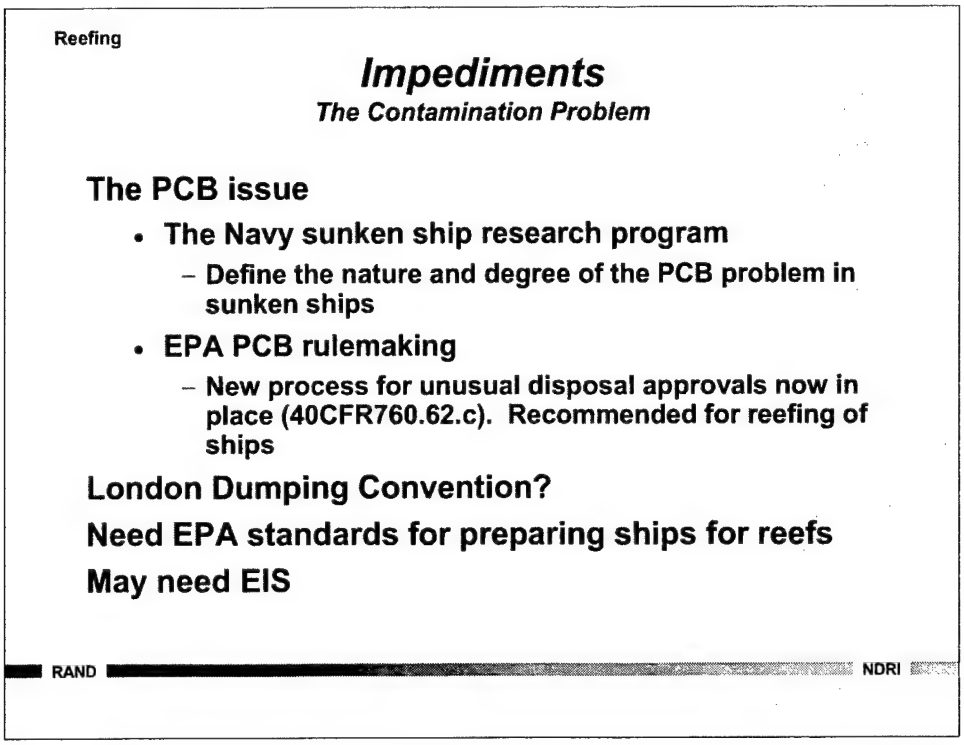
NFEA also required NMFS to prepare a National Reef Plan (Stone, 1985) to describe suitable reef building materials and processes. The plan was written and is being revised. However, no mechanism has been established for funding its provisions.

Related programs could offer useful lessons for a Navy/MARAD ship-reefing program. For example, the Army has sunk many tanks for reefs over the years after using reservist labor for much of the cleanup, and the Coast Guard reefs its unwanted ships.



The Federal Aid in Sport Fish Restoration (SFR) Act provides for excise taxes on fishing equipment and boat fuel. Funds are used for a wide range of fresh-water and salt-water fishing conservation activities, including a small amount, perhaps $1M per year, for reef building.

Conceptually, SFR funds could be used for cleaning and reefing Navy and MARAD ships, but a reasonable program would require about $25M per year. This would be a big boost over current SFR funding of reef building programs and would likely be opposed by other claimants. This program, thus, does not appear to be a suitable vehicle for funding a ships-to-reef program.

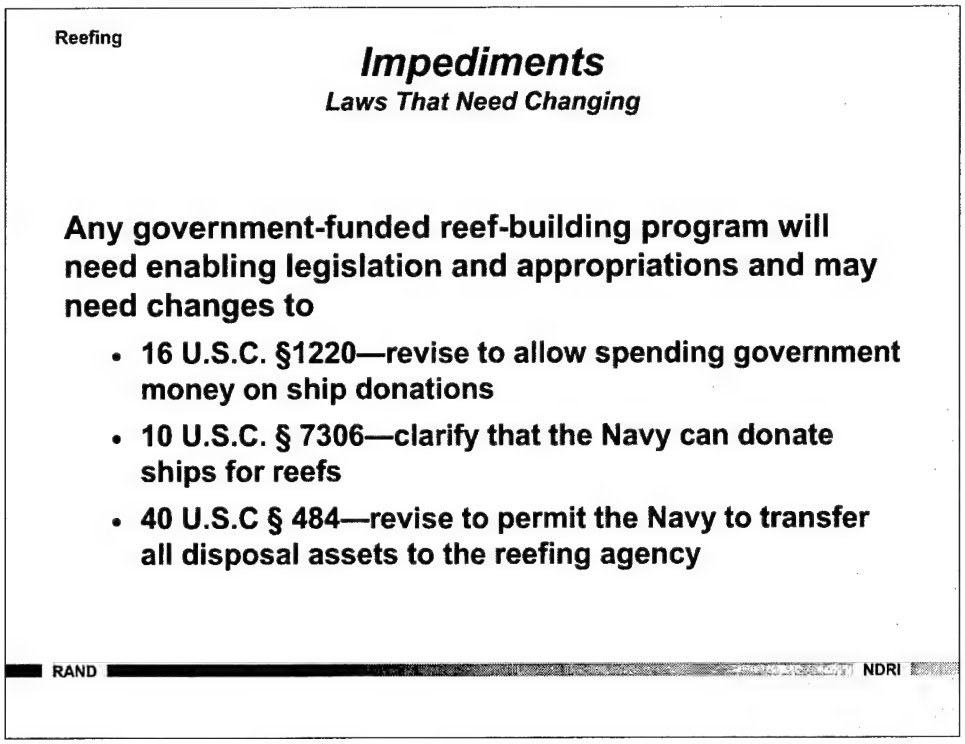


During the past several years, the Office of the Chief of Naval Operations (OPNAV) N45 and Naval Sea Systems Command (NAVSEA) have been conducting a research program to determine whether or not PCBs in sunken ships are an environmental problem. The results are nearly in and appear to be encouraging. The EPA has so far agreed that sinking exercises can resume and, based on recent conversations with the RAND team, appears positioned to agree with reefing. EPA PCB rules provide a path to formal approval of a reefing program.

For other potential contaminants, such as oil and asbestos, there is no accepted nation-wide standard. An EPA-issued guideline or standard, similar to the recent guideline put forth for ship scrapping, is needed. EPA's office of Federal Facilities Enforcement has advised us that such a standard could be set. The EPA would use Canadian standards as the baseline.

There is some concern that reefing under the EPA PCB rules might conflict with restrictions under the London Dumping Convention. This is a legal question for the Navy to address.

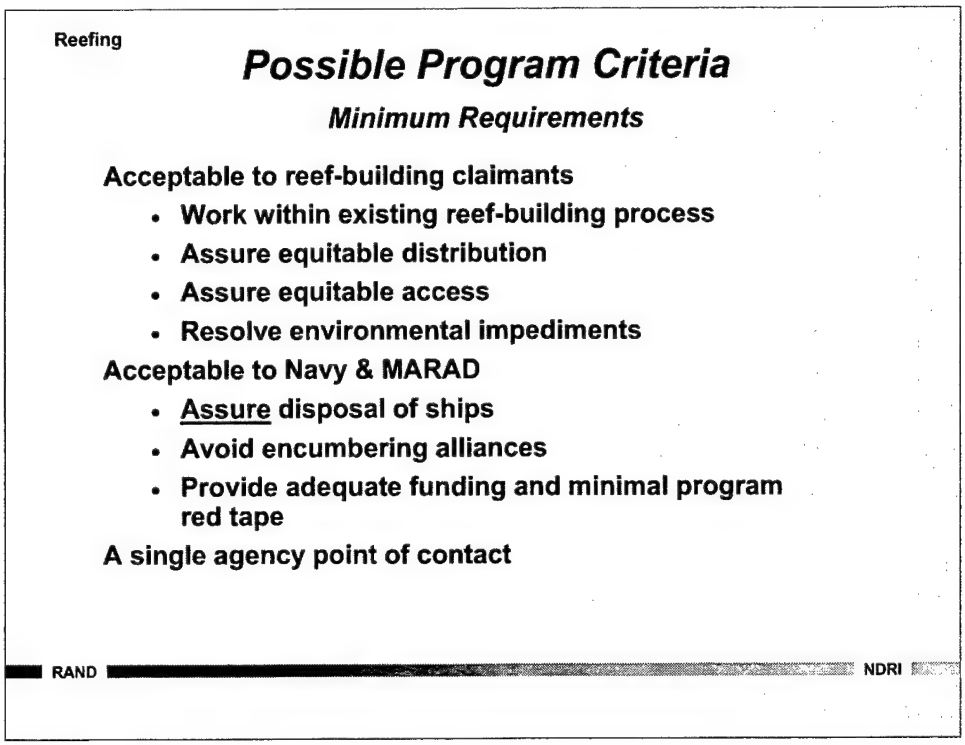
An Environmental Impact Statement (EIS) may be needed to address all these issues. Other changes to law are needed to provide the basic authority for reefing under EPA PCB rules.



According to Hess et al. (2001), a suitable budget for a reef-building program would be from $25 to $35 million per year for nearly 20 years. Such expenses are too large to take from Navy/MARAD operating funds. Separate appropriation and enabling legislation will be needed. In addition, there are some issues to resolve in such legislation:

1. 16 U.S.C. § 1220 presently permits MARAD to donate ships for reefs but only on an as-is, where-is basis and at no cost to the federal government. Depending on the business plan, this law may need revision.
2. 10 U.S.C § 7306 permits the Navy to donate ships for civilian uses, but it appears that the law is intended for museum donations, and it is not clear that it permits the Navy to donate ships for reefs. Although under this law, the Navy has recently donated ships that were eventually used as reefs, those donations have involved ships whose titles have been transferred to MARAD, which was then solicited for use of the ships as reefs. This law would have to be changed only if the Navy retains responsibility for donating ships for reefing, instead of handing over the authority to MARAD or another separate agency.

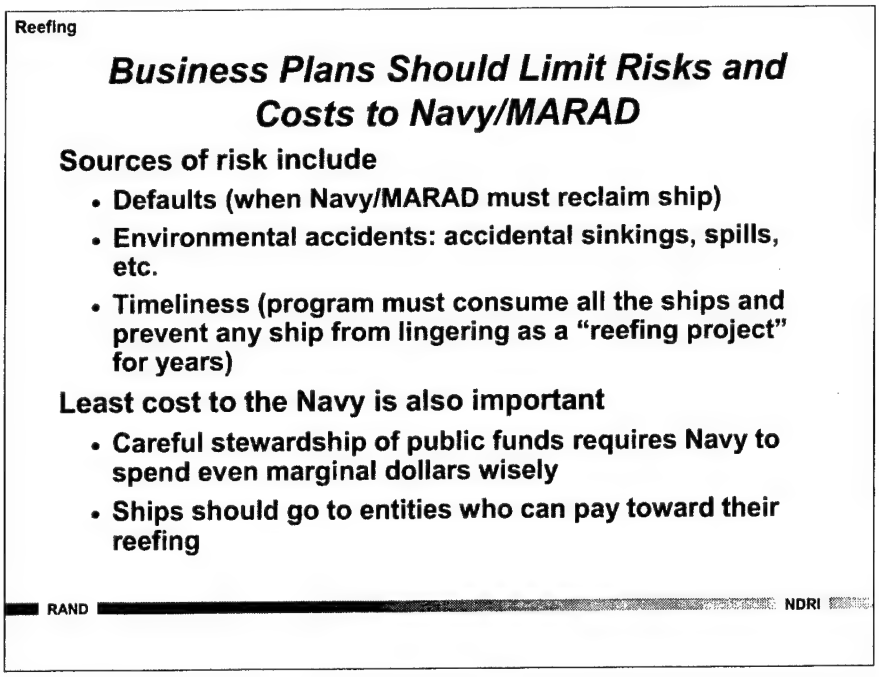
3. 40 U.S.C. § 484 will need to be changed if there is to be a single agency running a reef-building program. This title presently permits the Navy to transfer all ships displacing 1,500 tons or more that are commercial or commercial-like vessels to MARAD for disposition. In practice, this means that all ships except warships and small vessels have been "disposed of by title transfer" to MARAD. If there is to be a non-Navy managing agency for a reefing program, the Navy would need broader legal authority to transfer title to ships. Presumably warships would be demilitarized before title transfer. The law would have to include provisions making it clear that the Navy can retain any vessel needed for Navy purposes, such as sinking exercises, spare parts, or foreign sales.



A reef-building program with its necessary legislative, regulatory, and procedural package must fulfill criteria that are acceptable to both those who want the reefs and the Navy and MARAD. From a reef-builder's standpoint, the program must work within existing reef-building practices, assure equitable distribution of the assets among claimants, assure equitable access to all users, and be environmentally acceptable.

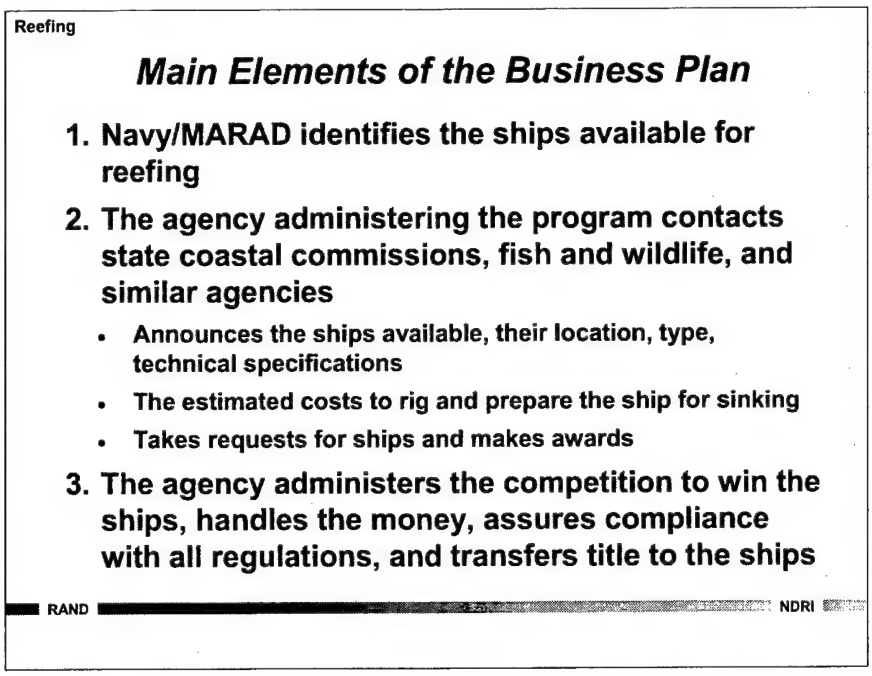
From the Navy and MARAD standpoint, the program has only one goal: get rid of the ships. Any plan that does not do this leads to domestic recycling or indefinite storage at higher cost and without future business or tax benefits. And there must be funding.

To make a ships-to-reefs program tractable from a state perspective, we believe that there should be a single federal agency serving as the point of contact, whatever the business model. The single agency concept could go as far as having one agency be responsible for the whole program.



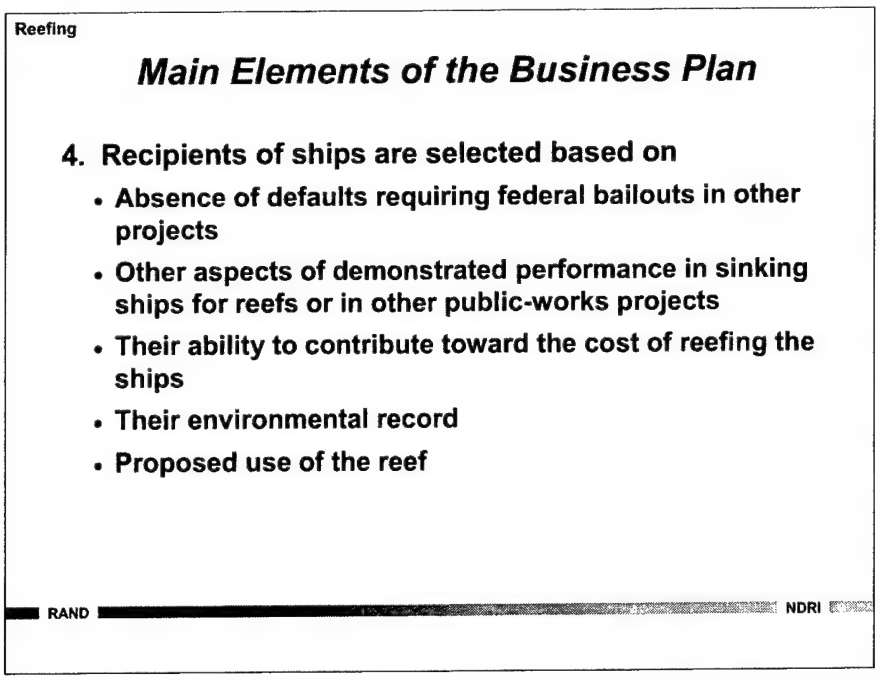
Whatever the final business plan, its principal focus should be to limit risks and costs to the Navy and MARAD. The business plan should result in a reefing program that limits the chances for defaults and environmental accidents, and that ensures that the ships become part of reefs in a timely manner. Such an approach reduces the likelihood that the Navy or MARAD will have to reclaim a ship if a reefing firm cannot successfully complete the reef project.

Least cost to the Navy is also an important consideration. The principle of careful stewardship of public funds suggests that the Navy should spend even marginal dollars wisely, and therefore, the Navy should favor those states whose proposals include the contribution of funding toward reefing a ship, even if the amount is only nominal.



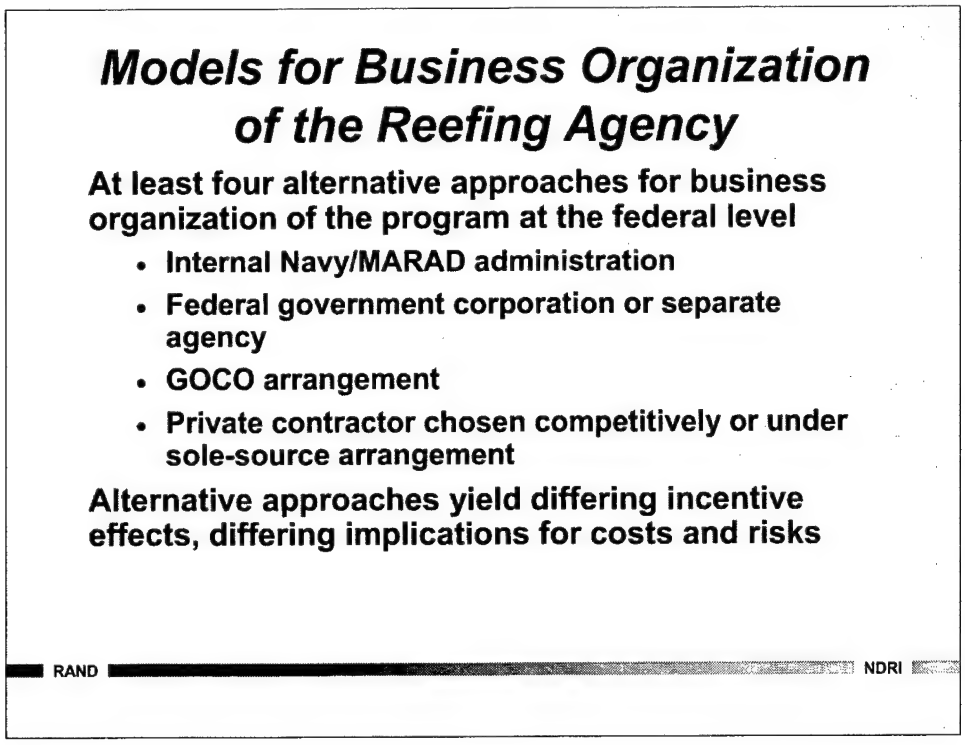
The chart above lists three of the four main elements that a sound reef-building business plan might have:

1. The Navy and MARAD identify the ships that are available for reefing in a given year and pass the information to the agency that is administering the reefing program.
2. We believe that the agency administering the program should deal only with states or federal agencies. A federal entity should not be expected to resolve competing claims for ships arising within a state. Next, this agency contacts state officials to announce that ships are available and invite requests for them. The reefing agency makes available all the technical information necessary to support a state's decision.
3. As the states respond, the reefing agency records the requests, evaluates the requestors from the perspective of risk, and makes its awards of ships to the claimants. The agency also manages all the administrative details: paying the contractors who actually prepare the ships, enforcing all relevant regulations, and ultimately transferring title to the ship at some point in the transaction.

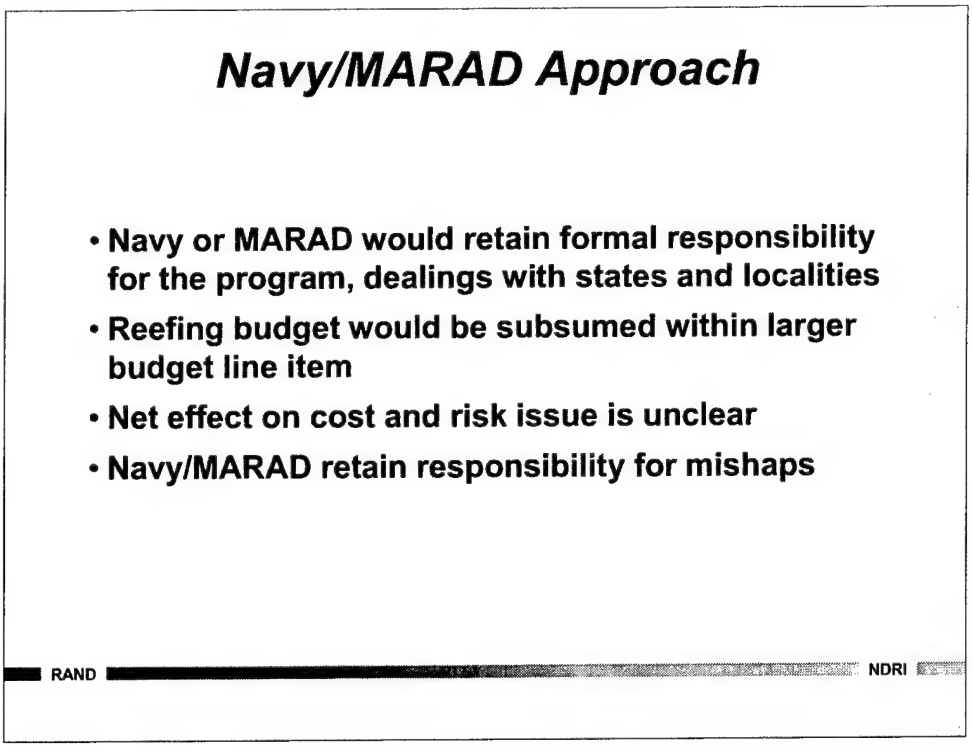


4. The fourth key element of the business plan is the criteria for selecting ship recipients. Through these criteria, the agency would hope to manage risk and select those recipients most likely to be successful in reefing the ships they are given. The reefing agency would award the ships to the states with the soundest records of performance, the greatest cost contribution, the best environmental record, and the best planned use of the reef from a business or ecological standpoint.

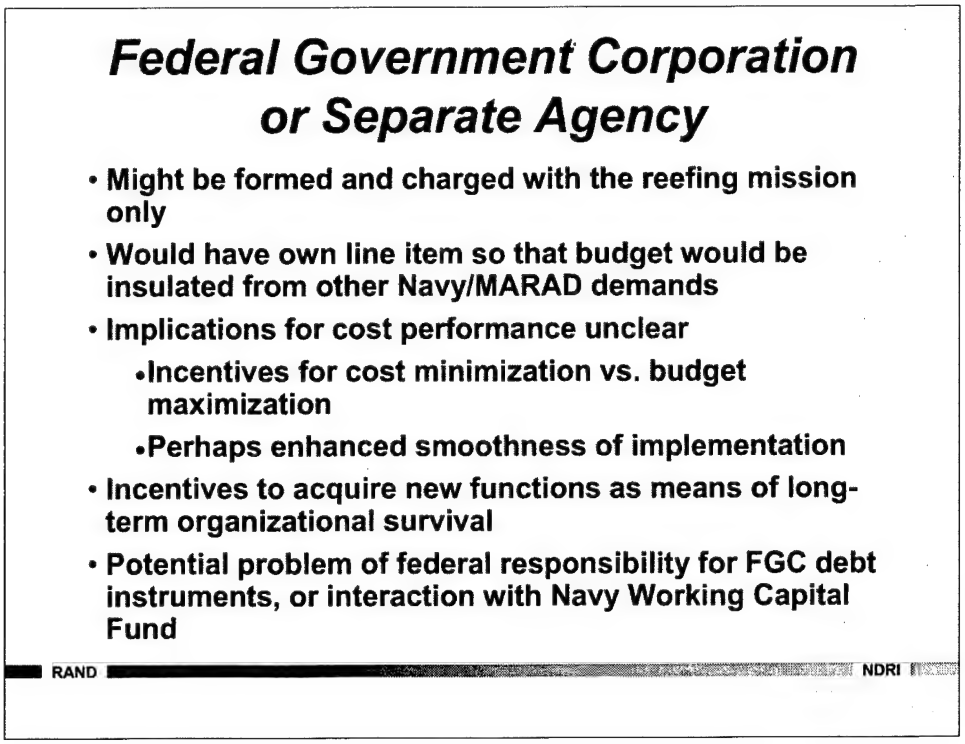
The decision process based on these criteria and the judgments of the reefing agency may become contentious if the demand for ships exceeds the supply. Each state, local government, or private reef proponent will want its share. Considerable thought must be given to ensuring a fair decision process.



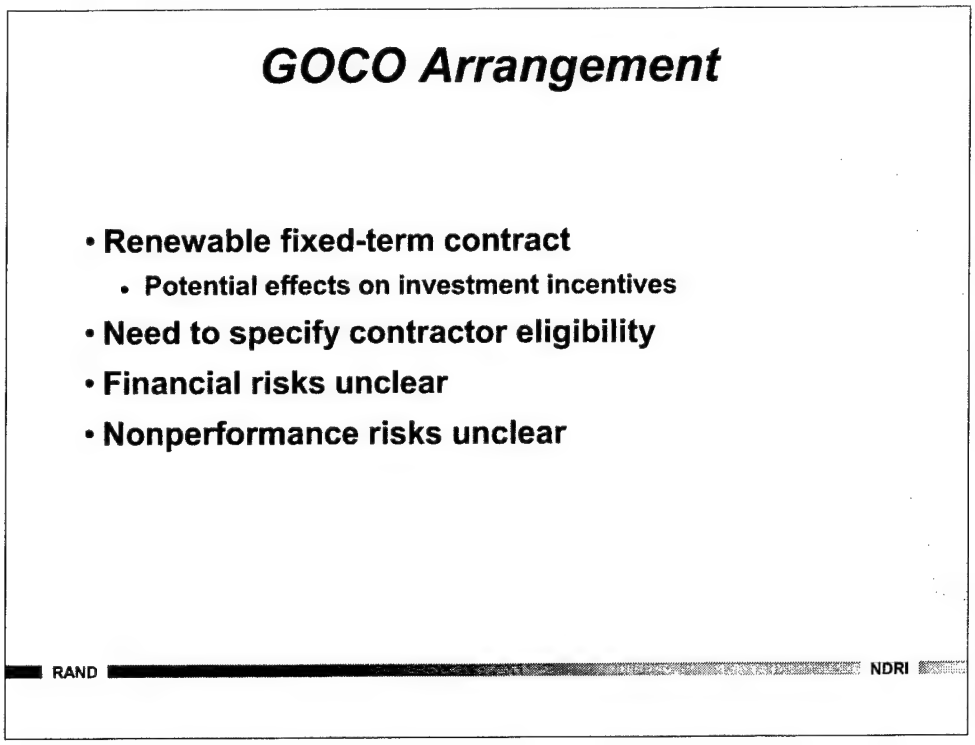
The discussion thus far has emphasized several operational aspects of a reefing program but has not addressed the question of the preferred nature of the federal government agency responsible for organizing and implementing the program. This issue carries important implications for costs and risks because the alternative approaches yield differing organizational incentives and thus differing expected performance.



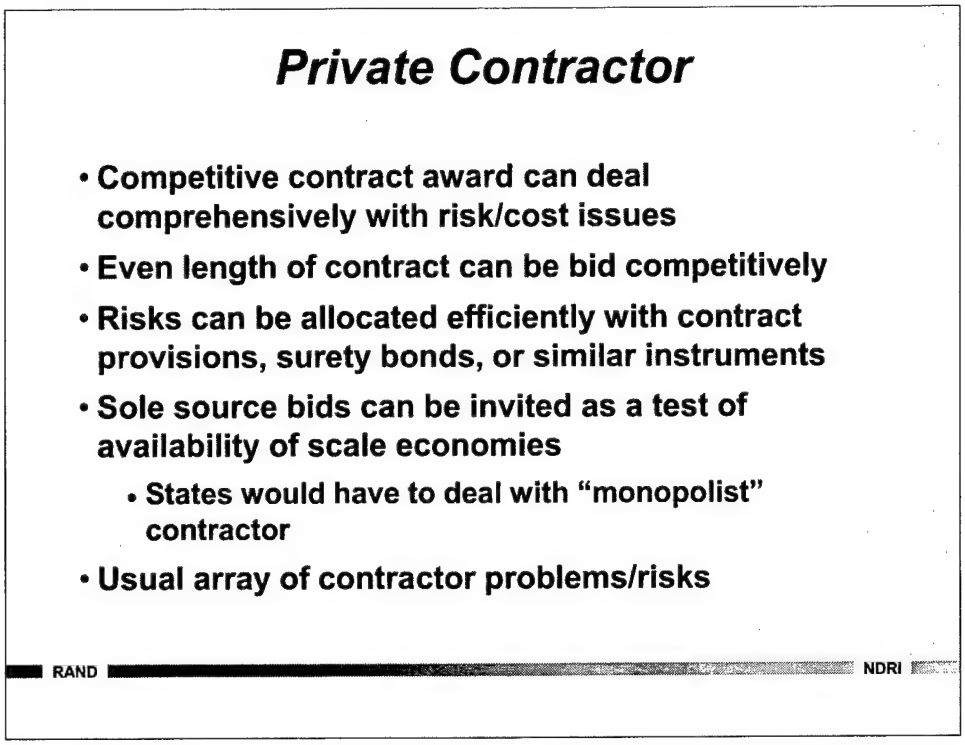
Because the Navy/MARAD under this option would maintain control of the program, there are some risks that might be reduced; an example is the reduced risk of nonperformance by an outside entity. At the same time, a reefing budget subsumed within, say, an operations and maintenance (O&M) budget category might be subject to short-term reallocation because of budget pressures affecting other activities. The reefing program might then be subjected to a start-stop-slowdown dynamic not consistent with smooth implementation. The resulting stretch-outs and related effects will increase life-cycle costs for the program. The cost analysis presented earlier indicated substantial returns from learning through experience, but learning is likely to occur only if the program is continuously funded over the long term.



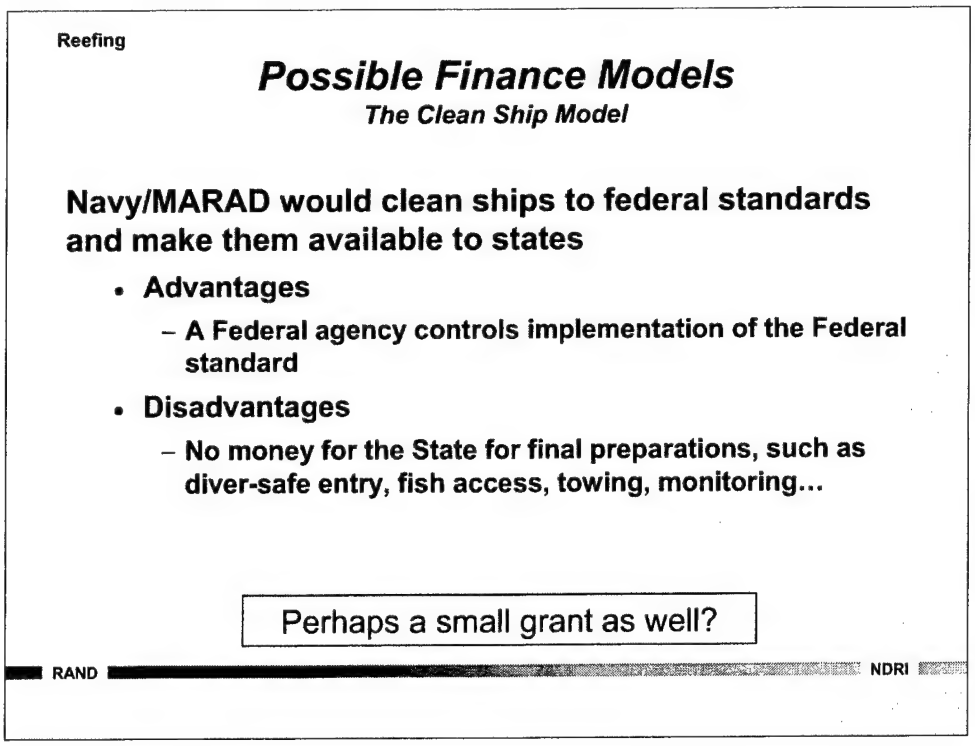
One method for avoiding the potential problem of budget "leakage" into unrelated activities might be to transfer the reefing function to a federal-government corporation (FGC) or separate federal agency with its own line-item budget authority for reefing. This would protect the reefing budget from annual competition with other functions (except at the Congressional level); but the lack of such competition might yield higher than necessary costs. That latter effect might be offset partially, fully, or more than fully by greater implementation smoothness over time, yielded by the absence of pressures to siphon dollars from the ship disposal project into other O&M programs in any given fiscal year. It is also predictable that a reefing FGC or agency would be faced with organizational incentives to preserve itself. As the supply of ships to be disposed of dwindles, it will try to acquire new functions; thus, this approach might yield a new permanent agency competing within or with the Navy for future budget dollars.



A government-owned, contractor-operated (GOCO) arrangement would relieve the Navy of the implementation burden for the reefing program. There obviously would be a contract, the length of which would yield important tradeoffs between investment incentives on the part of the contractor and the ability of the Navy to ensure effective implementation without the risk of extended litigation. This approach might increase the complexity the Navy would face in terms of specifying the group of contractors eligible to bid, or the characteristics of the contractors that may respond to the call for proposals. Some contractors may be inadequately capitalized, which might increase the financial risk of future nonperformance. In either case, retention of ownership by the Navy, as entailed in this arrangement, represents a risk that may or may not be compensated fully by a cost savings (relative to surrender of ownership). It is unclear, in other words, that economic risk would be allocated efficiently in such an arrangement.

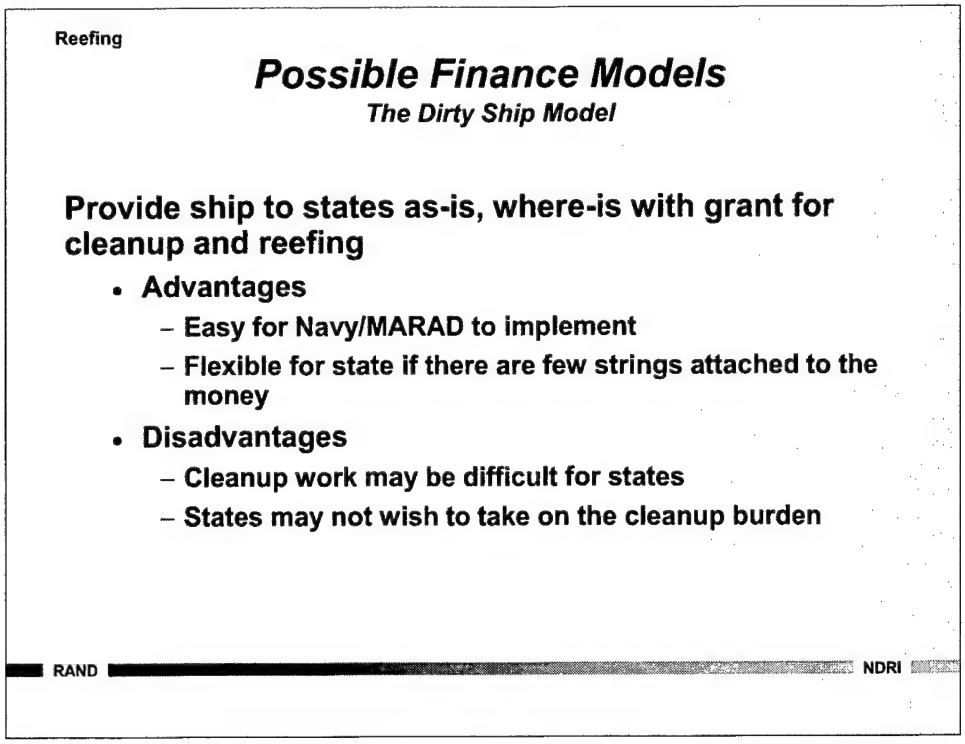


Implementation of a reefing program through contractors yields a different set of benefits and risks than implementation through the other entities. Program dollars would be insulated from other Navy demands, and cost-escalation risks could be reduced with fixed-price contracts (GOCO arrangements, in contrast, are generally cost plus fixed fee). Characteristics of the bids will offer insights into the efficient length of the contracts and other parameters, and some performance risks can be alleviated with a requirement for surety bonds or other similar instruments or with various contractual provisions. These contractual issues, however, raise a potential litigation problem. Insights into whether scale economies (or diseconomies) are incurred might be obtained if potential contractors are allowed to submit sole-source bids, although this could require states to deal with a "monopolist" contractor. The usual array of contractor problems and risks, long familiar in the defense community, would also have to be dealt with.



In the "Clean Ship" model, the program-managing agency would contract to clean the ship to the new EPA federal cleanup standards and would provide a "federally clean" ship to the states. Such a ship may or may not meet state cleanup standards and would not necessarily be prepared for diver-safe entry, for best use for fish propagation, or for any other purpose other than being safe for the environment in accordance with federal standards. In the absence of a single program agency, each agency that owns ships could argue for its own funding, would do its own cleanup contracting under this model, and would protect itself appropriately from poor contractor performance (and the bad press that would follow).

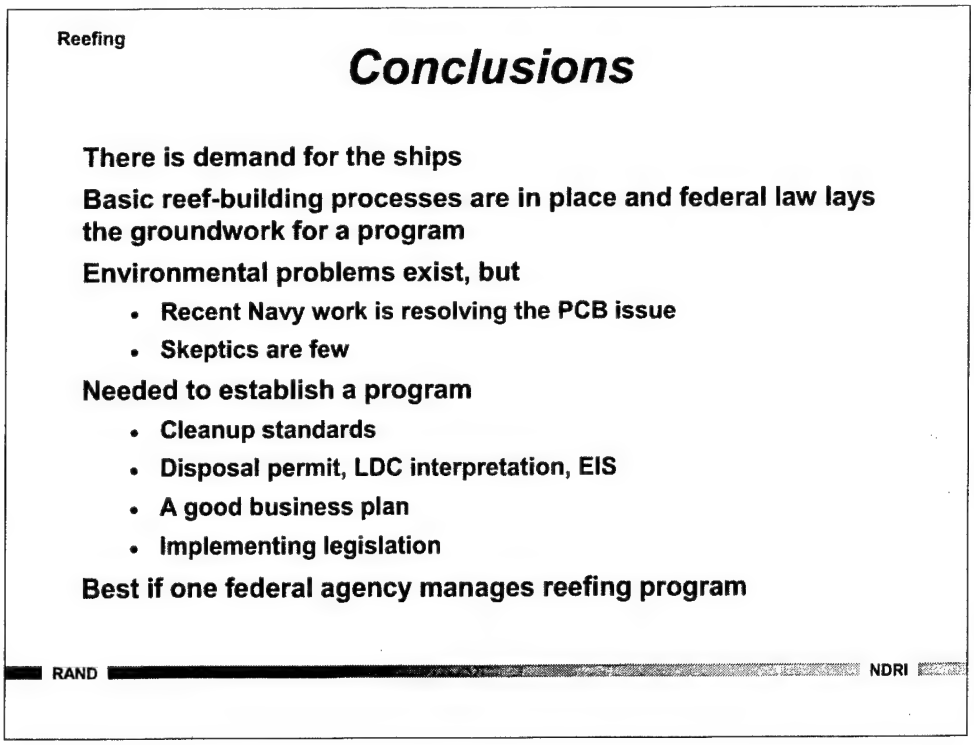
The clean-ship model might be easy for states to implement, and from our discussions with representatives from some states, this is the model they seem to prefer. However, states would have to fund any state-specific work themselves. (While they would have to fund the work, they might not have to do it themselves. An arrangement could be established whereby a state would pay the federal government to clean the ship to state criteria.) As an alternative, the program could include sufficient federal funding to also do the state-desired work or even a small "sweetener" grant that would fund state work and monitoring, much like the way the Rigs-to-Reefs program is funded by private sources.



The other extreme is the "Dirty Ship" model. Here, a state would request and receive a ship as it is, wherever it is, along with a grant estimated to be sufficient to clean up the ship and possibly convert it to a reef. The grant could be determined by a formula based on the size and complexity of the ship. The state would use the grant to remove the ship from government storage, prepare it for the intended reef, and then sink it. Any money left over could be used by the state for other reef-related activities. An approach along these lines has recently been suggested by Congress.

This program appears to be a simple one from the federal standpoint, but states may not want to become involved in the dirty work of ship preparation. Problems may also arise if the money runs out before the ship is reefed. In that case, who pays the balance? On the other hand, if grants are big enough, states would get to prepare each ship in the manner intended for its reef function—which could go beyond simple environmental cleanup—and also fund other reef-related work with whatever funds are left over.

Another possible finance model could be some combination of the clean-ship and dirty-ship approaches. But whichever approach is chosen, it must be acceptable to the reef-building states to assure successful disposal of the ships.



Our conclusions are as follows:

- There is demand for the ships.
- The basic processes for building artificial reefs, including building them using ships, are in place.
- There may already be sufficient guidance in federal law for funding a ships-to-reefs program.
- There are environmental issues, but they are being addressed by a Navy test program (Hess et al., 2001) in regard to PCBs and are probably solvable in regard to other issues.
- The Navy needs standards from the EPA for preparing ships, some internal work on PCB-disposal requests and the London Dumping Convention (LDC), and probably an EIS.
- The Navy needs a good business and finance model vetted with all of the concerned parties, followed up by appropriate legislation to implement the model, and, of course, money.

- It would be most helpful to reef-builders if there were a single federal point of contact. Likewise, it would be most efficient for the federal contact if it had to deal only with the states.

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